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The Value of Australian Franking Credits: Evidence from Global Equity Markets

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Declaration

I, *Hansi Hu*, declare that this thesis is submitted in partial fulfilment of the requirements for the conferral of the degree *Doctor of Philosophy*, from the University of Wollongong, is wholly my own work unless otherwise referenced or acknowledged. This document has not been submitted for qualifications at any other academic institution.

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Abstract

Exactly how franking credits influence the Australian equity market has sparked controversy among academics, regulators, politicians and practitioners since the introduction of the dividend imputation system in July 1987. Australia applied a classical tax system where corporate earnings are taxed twice, once at the corporate level and the second at the personal level on distributed dividends before July 1987. After the introduction of the imputation system to remove the double taxation, Australian resident shareholders who receive fully franked dividends are able to obtain a credit for the corporate tax that has already been paid. The discussion in the Australian Government (2014, 2015) triggers controversy among academics and practitioners on whether the imputation system should be modified or even completely revoked. The main topic of the debate is "whether franking credits are priced in the market". Despite much theoretical and empirical research, the evidence is mixed, and there is little consensus. This thesis enhances our understanding of the pricing of franking credits by providing evidence in the comparative pricing studies, the ex-dividend day studies, and the franking credit balances studies. The first research chapter provides direct evidence that differences in the tax systems between Australia and the UK, especially dividend imputation tax credits, are a statistically-significant factor in explaining this premium between the Dual-Listed Company (DLC) twins of BHP and Billiton. This chapter extends the comparative pricing studies literature by proposing a method to compare the American Depositary Receipts (ADRs) prices of DLC twins in the comparative pricing studies of franking credits. The second research chapter explores the implications of the ex-dividend period irrational exuberance by proposing the explanation that individual investors irrationally overvalue dividends and franking credits due to behavioural finance reasons. This chapter contributes to the existing ex-dividend date studies literature by examining the impact of dividends and franking credits surrounding the ex-dividend date using a longer horizon. The third research theme further investigates the market valuation and determinants of franking credit balances to fill in the gap in franking credit balances studies, which has been scarce to date. Each of these studies shows that franking credits are valuable in the hands of resident shareholders and that they are reflected in the market capitalization of firms. Finally, our results provide direct evidence on the debate of whether the imputation system should be abandoned in Australia. Our findings suggest that the imputation system should not be removed without a change

in other tax rules (e.g., personal tax rate). Share prices in Australia are predicted to drop sharply if Australia abandoned the imputation system while retaining the same personal income tax system regime.

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Abbreviations

ADRs	American Depositary Receipts
AETH	Australian Equities Tick History
ASX	Australian Securities Exchange
BHP	BHP Group Limited
Billiton	BHP Group Plc
CAPM	Capital Asset Pricing Model
CGT	Capital gains tax
CHESS	Clearing House Electronic Sub-register System
CMCRC	Capital Markets Cooperative Research Centre
CNMZ	Chen-Novy-Marx-Zhang
CPI	Consumer price index
CRA	Conzinc Riotinto of Australia
DDM	Dividend Discount Model
DCF	Discounted cash-flow
DLC	Dual-Listed Company
DPR	Dividend reinvestment plan
EJC	European Court of Justice
FGLS	Feasible Generalized Least Square
GDP	Gross domestic product
GGM	Gordon Growth Model
ISFs	Individual Share Futures contracts
LEPOs	Low Exercise Price Options
LSE	London Stock Exchange
NYSE	New York Stock Exchange
OECD	Organization for Economic Co-operation and Development
OLS	Ordinary Lease Squares
ORC	Official cash rate
RIM	Residual Income Model
RTZ	Rio Tinto – Zinc
SIRCA	Securities Industry Research Centre of Asia-Pacific
SPPR	Share Price and Price Relative

S34	Thompson Reuters Ownership Data
UK	The United Kingdom
US	United States of America
WRDS	Wharton Research Data Services
XAOA	Australian All Ordinaries Accumulation Index

Chapter 1

Introduction

1.1 Background and motivation

Exactly how franking credits affect the Australian equity market has sparked controversy among academics, regulators, politicians, and practitioners since the introduction of the dividend imputation system in July 1987. Before July 1987, Australia applied a classical tax system in which corporate earnings are taxed twice, first at the corporate level and second at the personal level on distributed dividends. After July 1987, the imputation system was introduced, and the double taxation of corporate earnings was amended. Under the Australian dividend imputation system, Australian resident shareholders who receive fully franked dividends are able to obtain a credit for the corporate tax that has already been paid, and thus pay additional tax only when their marginal tax rate is higher than the corporate rate, while non-resident investors are unable to claim the franking credits (Australian Taxation Office, 2020h). Excess franking credits became refundable after regulatory changes in 2000. The motivation for introducing the imputation system was to integrate the corporate tax system with the personal tax system (Australian Government, 2015). The imputation system ensures that a firm's profits distributed as franked dividends to domestic shareholders are taxed only once at investors' marginal personal tax rates.

Franking credits play a vital role in the Australian economy. As evidence, in the Australian Government (2015), it is estimated that approximately \$19 billion of franking credits have been distributed to individual investors, superannuation funds, companies, and charities, \$10 billion of which has been credited directly into other Australian firms' revenues. Furthermore, an estimated value of \$12 billion of franking credits was allocated to non-resident investors who were unable to collect the franking credits. Despite these benefits, the imputation system is under risk of being modified due to its unattractiveness to international investment communities and also a gradual increase in required rates of returns, as documented in Australian Government (2014).

The discussion in Australian Government (2014, 2015) triggers controversy among academics and practitioners on whether the imputation system should be modified or even completely revoked. The main topic of the debate is "whether franking credits are priced in the market". Despite much theoretical and empirical research, the evidence is mixed, and there is little consensus. This thesis enhances our understanding of the pricing of franking credits by examining the mispricing of BHP Billiton ADR twins, the irrational exuberance during the ex-dividend period, and the market valuation of franking credit balances. Each of these studies shows that franking credits are valuable in the hands of domestic resident shareholders and that they are reflected in the market capitalisation of firms, thus providing insights on the debate of whether the imputation system in Australia should be abandoned or modified.

1.2 The controversy around the proposed termination of the imputation system

The debate escalated when some controversial issues were canvassed in Australian Government (2014) and again in Australian Government (2015). Although the imputation system provides significant benefits, several issues need to be addressed due to the globalisation of the Australian market. Australian Government (2014) argued that franking credits distort Australian's allocation of funds by incentivising Australian residents to favour domestic investments. At the same time, it also brings negative impacts on Australia's competitiveness in the international arena in terms of investment equality and opportunities for those non-Australian residents. In addition, the imputation system is noted to exist within a tax system with a relatively high corporate tax rate, which contributes to an increase in the required rate of return for non-resident investors to some extent, as well as for domestic investors. However, there is yet insufficient empirical evidence to support these assertions (Davis, 2016; Ainsworth, Partington, and Warren, 2016b), especially evidence that outlines potentially adverse consequences that would arise if the imputation system was removed.

From an investor's perspective, the imputation system offers a subsidy to Australian resident investors. Franking credits reduce the tax wedge of Australian resident investors, specifically those investors whose marginal tax rate is lower than the corporate tax rate (Australian Taxation Office, 2020a). Whist Australia arguably has relatively high individual tax rates compared to many international economies, its effective tax rate on franked dividends is low compared to other Organization for Economic Co-operation and Development (OECD) countries that adopt a classical tax system in which dividends are subject to double taxation (Davis, 2016). Davis (2016) argues that if the Australian government shifts from the imputation system to a classical system in which the corporate tax rate generates the same amount of government tax revenue, low tax-rate investors' welfare would be undermined due to distributional consequences and share prices would be substantially and negatively impacted. From a corporation perspective, the imputation system also provides considerable benefits. Many studies, for example, Davis (2016) and Pattenden and Twite (2008), reach a consensus that the imputation system significantly benefits the Australian economy by reducing leverage and increasing the dividend payout ratio, thus contributing to market stability. If the imputation system were replaced with a classical system, the existing corporate structure and dividend policy would be distorted in an unfavourable direction.

Nevertheless, there is no general agreement on the impact of the imputation system on share prices and the cost of equity. In theory, in the case of the after-tax return, if the tax wedge is low, the net income that the firm needs to generate to meet investors' required rate of return would also be lower if the tax on the distribution of that income is lower. Ainsworth et al. (2016b) assert that franking credits reduce the cost of equity as well as increase share prices. However, Lajbcygier and Wheatley (2012) and Siau, Sault, and Warren (2015) argue that it is of importance to consider not just the Australian resident investors' required returns but also foreign investors' in the examination of the tax credit impact on the equity pricing as foreign investors are not eligible to receive any tax benefits under Australian imputation regulations.

The central question of the debate is whether franking credits are priced in the market - a topic that remains unclear. Several scholarly papers have attempted to shed light on this question. The pricing of franking credits is an empirical issue as there is a lack of theoretical explanation. There are three main streams of literature that investigate the pricing of franking credits. The first stream is comparative pricing studies that examine the value of franking credits by comparing the prices of instruments that are the same in their underlying aspects but differ in their entitlement to franking credits (e.g., McDonald, 2001; Cannavan, Finn, and Gray, 2004). The second stream is ex-dividend drop-off studies based on the assumption that the dividend price drop-off on the ex-dividend date should be equal to the sum of dividend amount and the franking credits (e.g., Brown and Clarke, 1993; Bellamy, 1994; Walker and Partington, 1999; Bellamy and Gray, 2004; Beggs and Skeels, 2006; Feuerherdt, Gray, and Hall, 2010; Vo, Gellard, Mero, and Authority, 2013; Ainsworth et al., 2016b). The third stream is the required rate of return studies that investigate the relationship between franking credits and the required rate of return (e.g., Wood, 1997; Lajbcygier and Wheatley, 2012; Siau et al., 2015). However, the empirical evidence is mixed, and the debate is still inconclusive. Therefore, evidence on the implications of removing the dividend imputation tax system needs to be provided before the system is substantially modified or even abandoned.

1.3 Rationale for the research chapters

This thesis provides insights on the debate of whether the imputation system should be abandoned in the Australian equity market by providing direct evidence on whether franking credits are priced and enhancing our understanding of how franking credits are priced.

The first research chapter aims to explain the price premium of BHP ADR twins. BHP Billiton was formed in 2001 when BHP in Australia merged with Billiton in the UK to form a Dual-Listed Company (DLC). The ADRs for BHP and Billiton trade on the NYSE, and despite these two securities having the same US dollar-denominated dividends, the BHP ADR generally sells at a premium to the Billiton ADR, though that premium has considerable time-series variation. We investigate whether differences in the imputation tax systems that apply to dividends in Australia and the UK [which results in BHP selling at a premium on the Australian Securities Exchange (ASX) relative to Billiton on the London Stock Exchange (LSE), after allowing for exchange rate adjustments] help explain the time-series variation in the premium of the ADR prices. The findings confirm that imputation tax differences are a significant determinant of the premium. Theoretically, this chapter modifies the original Gordon Growth Model (GGM) (Gordon and Shapiro, 1956) and the original Residual Income Model (RIM) (Ohlson, 1995) by replacing distributed dividends and residual income with after-tax dividends and after-tax residual income which incorporate personal tax rates and franking credits. This chapter extends the literature on the application of GGM and RIM as it provides evidence that tax factors should be considered in these two valuation models. Empirically, this chapter provides direct evidence that differences in the tax systems between Australia and the UK, especially dividend imputation tax credits, are a statistically-significant factor in explaining this premium between the BHP twins documented in the existing literature (Froot and Dabora, 1999; Bedi, Richards, and Tennant, 2003; De Jong, Rosenthal, and Van Dijk, 2009; Su, Yi, Hooper, and Dutta, 2013). Finally, this chapter thus extends the comparative pricing studies literature by providing direct evidence that imputation tax credits are capitalised into equity prices.

The second research chapter explores the implications of the ex-dividend period irrational exuberance in the following three steps. Firstly, while most existing ex-dividend drop-off studies intentionally restrict their investigation window to short periods around the ex-dividend day, this present investigation examines the price movements during a 100-day window surrounding the ex-dividend date. Secondly, the investigation employs a behavioural finance based individual dividend clientele argument to explain individual investors' investment decisions in response to the irrational exuberance. In particular, the investigation places emphasis on the irrationality of investors in their over-valuation of dividends and franking credits, and their preference to take a long position before the ex-dividend date and to sell those securities afterwards. The empirical results in this chapter contradict other taxation-induced literature (Feldstein and Green, 1983; Shleifer and Vishny, 1986; Redding, 1997; Brav and Heaton, 1998; Allen, Bernardo, and Welch, 2000). Thirdly, the investigation incorporates franking credits in the individual dividend clientele and the irrational exuberance arguments. Overall, the findings suggest individual investors irrationally overvalue dividends and franking credits due to behavioural finance reasons (Gordon, 1963; Lintner, 1964; Dennis and Strickland, 2002; Barber and Odean, 2013), and hence shifts from a long position to a short position during an ex-dividend event, thus contributing to the ex-dividend period exuberance. Besides, there is no direct evidence that relates foreign ownership with the valuation of franking credits. Ultimately, this chapter extends the ex-dividend drop-off studies literature by examining the overall influence of dividends and franking credits for the whole ex-dividend period.

This third research theme further investigates the valuation of franking credit balances via a determinant analysis and value relevance analysis. The literature on these studies has been scarce, with Heaney (2009) being the first to investigate the topic. However, Heaney's (2009) research does not differentiate between individual and institutional shareholders; and domestic investors or international investors. This present investigation extends Heaney's (2009) research by incorporating ownership characteristics into the franking credit balances studies. Tanza (2014) follows Heaney (2009) to extend the literature. This chapter extends and improves Tanza's (2014) value relevance model by applying a log-transformation to reduce the skewness and improving his model to reduce multicollinearity. The determinant analysis examines the determinants contributing to the increasing cumulative level of franking credit balances. The fixed effects panel data OLS regression provides strong evidence of a size effect that the level of franking credit balances increases with firm size and weak evidence of an international focus effect that the level of franking credit balances increases with international ownership. We also find an individual dividend clientele effect that the level of franking credit balances decreases with individual ownership. Value relevance studies explore whether franking credit balances are priced in the market. We find significant evidence that franking credit balances are priced in the market, and one dollar of franking credit is worth 1.4 dollars in firm value. Further, this chapter relates the market valuation of franking credit balances to firm size and international focus and finds that the market valuation increases with firm size but decreases with international focus. Overall, this chapter extends the franking credit balances studies literature, which has been scarce to date with Heaney (2009) and Tanza (2014) being the only closely relevant studies through improvements in their data source and methodology.

Each of these three research themes provide direct evidence to answer the question of whether franking credits are priced in the Australian and international equity markets. Our findings are consistent with evidence of some researchers (e.g., Brown and Walter, 1986; Brown and Clarke, 1993; Bellamy, 1994; Walker and Partington, 1999; McDonald, 2001; Vo et al., 2013; Ainsworth et al., 2016b), while they contradict the evidence of other researchers (e.g., Cannavan et al., 2004; Bellamy and Gray, 2004; Beggs and Skeels, 2006; Feuerherdt et al., 2010). Overall, our results provide direct evidence on the pricing of franking credits, thus contributing to the debate of whether the imputation system should be abandoned in Australia. Our findings suggest that the imputation system should not be removed without a change in other tax rules (e.g., personal tax rate). Share prices in Australia are predicted to drop sharply if Australia abandoned the imputation system while retaining the same personal income tax system regime.

1.4 Organization of the thesis

The thesis is structured with six chapters. Chapter 1 introduces the whole thesis. Chapter 2 describes the Australian imputation tax system and reviews the four main streams of the literature, which are comparative pricing studies, ex-dividend drop-off studies, required rate of return studies and other studies. Chapter 3, Chapter 4, and Chapter 5 address the hypotheses, data, methodology and results for three research themes respectively. Chapter 6 summarises the key findings of the three research themes and draws the main conclusions of the thesis.

Chapter 2

Literature Review

2.1 Introduction

This chapter reviews the literature on the market pricing of franking credits. It begins with an introduction that outlines the main elements of the Australian imputation tax system, with particular attention to changes in rules related to franking credits in Section 2.2. This chapter then reviews the theoretical studies about the valuation of franking credits in Section 2.3. Next, this chapter presents empirical and experimental literature on the debate of whether franking credits are priced in the market in Section 2.4. Three main streams of literature and other studies are described in this part. Finally, this chapter concludes in Section 2.5.

2.2 Australian tax system

2.2.1 Imputation system versus classical system

Before July 1, 1987, Australia was operating under a classical tax system, which imposes double taxation on corporate earnings. The first tax is the corporate tax on corporate taxable income. The second tax is the personal income tax payable on distributed dividends. On July 1, 1987, Australia changed the tax system, moving from the classical tax system to the current system, which is known as the "imputation tax system" with the ultimate objective of eliminating the double taxation of corporate earnings. Under the imputation tax system, investors can offset their tax payable on distributed dividends via the reimbursement of franking credits. (Australian Taxation Office, 2020h).

Under the imputation system, corporate entities can distribute dividends with franking credits that can be used by resident investors to offset the personal income tax. Suppose a company pays out all of its after-tax net income as a dividend *DIV* to an Australian resident investor, the amount of the attached franking credits is equal to part or all of the corporate taxes τ_c that the company has paid on its income (Australian Taxation Office, 2020a). The grossed-up dividend or "franked" dividend is equal to a cash dividend with franking credits. The net (after-tax) dividend received ($DIV/(1-\tau_c)*(1-\tau_p)$) is equal to the grossed-up dividend after the personal income tax τ_p.

A specific comparison of cash flow from a company to investors between the imputation tax system and the classical tax system is shown in Table 2.1[1]. The table shows an example under the dividend imputation system where an Australian resident tax-paying investor with a 47% personal income tax rate (including a 2% medical levy) obtains a net dividend of \$37.1. In contrast, an investor under a classical system only receives \$25.97 after the corporate tax and the personal income tax with the same payout ratio of 70%. Under a dividend imputation system, an Australian resident tax-paying investor receives a net dividend that is 43% higher than that under a classical system.

[1]The tax rates in Australia in 2019-2020 are used in this table. Historical corporate tax rates and personal income tax rates are shown in Table A.1 in Appendix A.

Table 2.1: Comparison of cash flow between the imputation system and the classical system

This table compares the cash flow from a company to investors through cash dividends between the dividend imputation tax system and the classical tax system. The table assumes an operating income of \$120, an interest payment of \$20, a corporate tax rate of 30%, a payout ratio of 70%, and a personal tax rate of 47% in both the imputation and classical system and the dividend is fully franked in the imputation system. All numbers in the table are in Australian dollars. This table is sourced from Cannavan et al. (2004) with amendments.

Cash flow	Imputation system		Classical system	
	General expression	Num	General expression	Num
Company level				
Operating income	X_O	120	X_O	120
Less interest payment	X_D	(20)	X_D	(20)
Taxable income	$X_O - X_D$	100	$X_O - X_D$	100
Less corporate tax	$(X_O - X_D)(\tau_c)$	(30)	$(X_O - X_D)(\tau_c)$	(30)
After-tax net profit	$(X_O - X_D)(1-\tau_c)$	70	$(X_O - X_D)(1-\tau_c)$	70
Payout ratio	pr	70%	pr	70%
Cash dividend	$(X_O - X_D)(1-\tau_c) * pr$	49	$(X_O - X_D)(1-\tau_c) * pr$	49
Stockholder level				
Cash dividend	$(X_O - X_D)(1-\tau_c) * pr$	49	$(X_O - X_D)(1-\tau_c) * pr$	49
Franking credits	$(X_O - X_D) * pr * \tau_c$	21		
Gross dividend	$(X_O - X_D) * pr$	70		
Personal tax liability	$(X_O - X_D) * pr * (\tau_p)$	(32.9)	$(X_O - X_D)(1-\tau_c) * pr * (\tau_p)$	(23.03)
Franking credit offset	$(X_O - X_D) * pr * \tau_c$	21		
Net tax payment	$(X_O - X_D) * pr * (\tau_p - \tau_c)$	(11.9)	$(X_O - X_D)(1-\tau_c) * pr * (\tau_p)$	(23.03)
Net (After-tax) dividend	$(X_O - X_D) * pr * (1-\tau_p)$	37.1	$(X_O - X_D)(1-\tau_c) * pr * (1-\tau_p)$	25.97

2.2.2 Fully franked dividend, partly franked dividend, and unfranked dividend

A dividend can be distributed with fully franked imputation credits, partly franked credits, or without credits (i.e., unfranked) in Australia. Fully franked dividends are dividends that are distributed from net profit after corporate tax and carry imputation credits of the maximum corporate tax rate (Australian Taxation Office, 2020p). Rational application of Australian tax laws ensures firms will make dividends fully franked when possible (Cannavan et al., 2004). Only in the circumstances where firms have not paid Australian corporate tax on all of its profit, due perhaps to tax deductions arising from losses from previous years or when they receive net profits from overseas, will unfranked dividends with no imputation credits be distributed. Partly franked dividends are a mix of fully franked and unfranked dividends (Pattenden and Twite, 2008). Table 2.2[2] shows the differences in the cash flow from the company to its investors through a fully franked dividend, a partly franked dividend, and an unfranked dividend with the same payout ratio of 100%. The fully franked dividend is generated by Australian sourced income, and the unfranked dividend is generated by foreign sourced income. The partly franked dividend (75% in this example) can be interpreted as a mixture of a fully franked dividend with a weight of 75% and an unfranked dividend with a weight of 25%. Table 2.2 indicates that under the dividend imputation system, an Australian resident investor obtains a net dividend of $53 when receiving a fully franked dividend. In contrast, the Australian resident investor only obtains $39.75 if the dividend is unfranked. When 75% of the cash dividend is attached with franking credits, the Australian resident investor receives a net dividend of $49.69. The comparison is based on the assumption that the income of all three scenarios is $100 and that the corporate tax rate is 25% for foreign income and 30% for domestic income.

[2] The tax rates in Australia in 2019-2020 are used in this table. Historical corporate tax rates and personal income tax rates are shown in Table A.1 in Appendix A.

Table 2.2: Comparison of cash flow of cash dividends with different levels of franking credits attached

This table compares the cash flow from a company to investors of fully franked, partly franked, and unfranked dividends. The table assumes an Australian sourced taxable income of \$100 for fully franked dividend, a foreign-sourced taxable income of \$100 for unfranked dividend, a mix of Australian sourced taxable income of \$75 and foreign-sourced taxable income of \$25 for partly franked dividend, a corporate tax rate of 30% in Australia and 25% in a foreign country, a payout ratio of 100%, and a personal tax rate of 47%. All numbers in the table are in Australian dollars. This table is adapted from Cannavan et al. (2004) with amendment.

Cash flow	Fully franked	Partly franked	Unfranked
Company level			
Australian sourced taxable income	100	75	0
Less Australian corporate tax	(30)	(22.5)	0
Australian after-tax net profit	70	52.5	0
Foreign-sourced taxable income	0	25	100
Less foreign corporate tax	0	(6.25)	(25)
Australian after-tax net profit	0	18.75	75
After-tax net profit	70	71.25	75
Payout ratio	100%	100%	100%
Cash dividend	70	71.25	75
Stockholder level			
Cash dividend	70	71.25	75
Franking credits	30	22.5	0
Gross dividend	100	93.75	75
Personal tax liability	(47)	(44.06)	(35.25)
Franking credit offset	30	22.5	0
Net tax payment	(17)	(21.56)	(35.25)
Net (After-tax) dividend	53	49.69	39.75

2.2.3 Eligibility of franking credits

This section investigates the eligibility rule on franking credits under the current tax regulations in Australia. Specifically, the entities that are eligible to distribute franking credits and four communities of investors are discussed. Since investors, depending on their status for tax purposes, vary significantly with regard to their accessible tax benefits from franking credits, it is critical to consider the differences among the four investor communities.

According to the definition in Australian Taxation Office (2020e), a "franking entity" is an entity taxed at a corporate tax rate. It can be a company, limited corporate partnership, corporate unit trust, or public trading trust. However, a company acting in its capacity as trustee of a trust and mutual life insurance companies are excluded in this definition. Investors in franking entities, if eligible, can obtain franking credits directly or indirectly through a trust or a partnership. The franking credits do not need to be grossed-up in individual investor's tax account as they have been grossed-up in the trust and partnership income.

There are four investment communities: (1) Australian taxpaying residents, (2) Australian superannuation funds, (3) Australian tax-exempt residents, and (4) international investors. Under the imputation system in Australia, franking credits can only be imputed against the personal tax obligations of Australian residents, which means investors in the first community are entitled to offset their tax liabilities with franking credits conditional on their tax rates (Australian Taxation Office, 2020f). Nevertheless, the tax advantages derived from the franking credits were not enjoyed by every domestic investor, specifically, not by those defined in low-income brackets (the second and third communities), until the introduction of tax rebate in July 2000. In particular, investors whose credits exceed their tax liabilities used to have unused franking credits since they could not obtain a refund of their (excess) franking credits. The July 2000 tax rebate described as rule 4 in Section 2.2.5 made these unused or excess franking credits accessible, and thus increased the value of imputation credits for investors in low tax brackets. In contrast, the fourth investment community, which are international shareholders (or commonly referred to as foreign residents for tax purposes), is not eligible to claim tax credits on their dividends (Australian Taxation Office, 2020p). A comparison of cash flows of different categories of investors is shown in Table 2.3[3], which assumes that the corporate tax rate is 30%, the personal income tax rate is 47%, the superannuation income tax rate is 15%, the payout ratio is 100%, and the taxable income is $100. Table 2.3 shows that an Australian resident investor receives a net dividend of $53, which is 43% higher than the net dividend of $37.1 obtained by international investors[4]. The difference is the same as the one between

[3]The tax rates in Australia in 2019-2020 are used in this table. Historical corporate tax rates, personal income tax rates, and superannuation funds income tax rates are shown in Table A.1 in Appendix A.

[4]Table 2.3 assumes a tax rate of 47% on the cash dividend for both Australian and international in-

investors under the imputation system and the classical system discussed in Table 2.1. The net dividend received by superannuation funds increased from $70 to $85 after the introduction of the tax rebate in 2000. Similarly, tax-exempt investors experience a growth in net dividend from $70 to $100 that is equal to the taxable income of the corporate after 2000.

vestors, so as to compare the tax treatments between Australian investors and international investors when controlling for personal income tax rates. It is possible that the international investors are in a tax bracket with tax lower than 47%, but this does not help a comparison. Further, even if an international investor is in a country where the income rate is lower than the income tax rate in Australia, this does not mean that these international investors would receive a higher net dividend as they are not eligible for franking credits.

Table 2.3: Comparison of cash flow of different tax brackets of investors

The table compares the cash flow from a company to investors for different tax brackets of investors. The table assumes a taxable income of $100, a corporate tax rate of 30%, a payout ratio of 100%, a income tax rate of 47% for Australian resident and international investors, 15% for superannuation funds and 0% for tax-exempt. All numbers in the table are in Australian dollars. This table is developed for this research.

Cash flow	Australian resident investors	International investors	Superannuation funds (before 2000)	Superannuation funds (after 2000)	Tax exempt (before 2000)	Tax exempt (after 2000)
Company level						
Taxable income	100	100	100	100	100	100
Less corporate tax	(30)	(30)	(30)	(30)	(30)	(30)
After-tax net profit	70	70	70	70	70	70
Payout ratio	100%	100%	100%	100%	100%	100%
Cash dividend	70	70	70	70	70	70
Stockholder level						
Cash dividend	70	70	70	70	70	70
Franking credits	30	0	30	30	30	30
Gross dividend	100	70	100	100	100	100
Personal tax liability	(47)	(32.9)	(15)	(15)	(0)	(0)
Franking credit offset	30	0	15	30	0	30
Net tax payment	(17)	(32.9)	0	15	0	30
Net (After-tax) dividend	53	37.1	70	85	70	100

2.2.4 Franking account

Corporate tax entities keep an account called a "franking account" which records the undistributed franking credits at the year end. The franking credits account records the amount of tax paid each year that a franking entity can pass on to its shareholders as franking credits. The franking account balance accumulates when the corporate entity does not allocate all of its available franking credits. In contrast, the franking account balance decreases when the corporate entity distributes franking credits or receives a tax refund (Australian Taxation Office, 2020e). The franking credit balances rollover from one financial year to the next. The franking account is in surplus if the sum of franking credits exceeds the sum of franking debits, and it is in deficit vice versa. The Simplified Imputation System (SIS) that penalises a corporate entity with a deficit franking account was introduced in 2002. Specific details of the SIS are described in rule 5 in Section 2.2.5.

2.2.5 Evolution of the Australian imputation system

After the introduction of the imputation tax system in 1987 in Australia, five major tax regime changes are highly relevant to franking credits. 1) Superannuation funds are eligible for franking credits after 1988; 2) anti-streaming rules were introduced to prevent dividend streaming in 1990; 3) holding period rules and related payments rules were implemented in 1997 to prevent trading of franking credits; 4) investors can claim a cash tax rebate for unused franking credits in 2000; 5) a SIS was introduced which converts the franking account from a "tax profit" basis to a "tax paid" basis. This section discusses these rule changes.

Rule 1: 1988 Superannuation funds are eligible to receive franking credits[5]. When the income tax was first introduced in Australia in 1915, superannuation funds were not taxed at all. Before 1983, end benefits could be paid out as a lump sum or an annuity. Only 5% of the lump sum was taxed at marginal rates, while all annuities were taxed at marginal rates (Reinhardt and Steel, 2006). The tax advantages of lump sums attracted more taxpayers to shift their retirement income to lump sum. This issue was addressed by the reform introduced in 1983 that increased the lump sum to 15% for amounts below a specified threshold and 30% for amounts above the threshold (Reinhardt and Steel, 2006). A further revision was the reform made in 1988 that superannuation funds, friendly societies, and selected deposit funds are required to pay income tax and capital gains tax at a flat rate of 15%. Meanwhile, they are eligible for franking credits (Commonwealth of Australia, 1989).

Rule 2: 1990 Anti-streaming rules[6]. Although the imputation system passes the benefit of corporate tax to its investors as franking credits, not all investors value the franking

[5] See Commonwealth of Australia (1989).
[6] See Australian Taxation Office (2020d)

credits equally, which creates an incentive for a company to stream franked dividends to those investors who most value the franking credits (Fisher, 1999). Specifically, under the dividend streaming scenarios, companies preferred to pay an unfranked cash dividend with a relatively higher amount to investors who do not value franking credits, such as international investors and investors with low tax liabilities, before the introduction of tax rebate rule in 2000 (Beggs and Skeels, 2006). The Australian taxation office applied a range of measures to prevent the streaming of dividends, including initial anti-avoidance provisions, specific anti-streaming provisions, third-generation provisions, and capital benefits anti-streaming rules (Fisher, 1999). Ultimately, anti-streaming rules were introduced in 1990 to penalise companies that directly distributed their franking credits to investors who most benefited from the franking credits (Beggs and Skeels, 2006). After the introduction of anti-streaming rules, firms have to apply the same rules to distribute franking credits to all investors equally, which reduces investors' ability to absorb the full benefits of franking credits.

Rule 3: 1997 Holding period rule and related payments rule[7]. The taxation office applied the "holding period rule" and the "related payments rule" to restrict the eligibility of franking credits in 1997 (Commonwealth of Australia, 1999). Investors might not be eligible to claim the franking credits if they violate these two rules. If the amount of an investor's franking credits is equal to or more than \$5,000, the investor has to meet both the "holding period rule" and the "related payments rule" no matter whether he holds the shares in one parcel or a portfolio consisting of multiple parcels. Conversely, if the amount of an investor's franking credits is less than \$5,000, the investor only needs to meet the "related payments rule". The part of franking credits that do not meet the requirements is not able to be claimed (Australian Taxation Office, 2020g). Both these rules aim to prevent the potential arbitrage opportunities of indirect trading of franking credits (Beggs and Skeels, 2006). The "holding period rule" was introduced in Australia after July 1, 1997. To claim the franking credits, the investor needs to hold the shares for at least 45 days (90 days for preference shares, not counting the day of acquisition or disposal). The rule applies to each purchase of shares. The rule takes effect when the amount of total franking credits that can be claimed for the year of income is above \$5,000 (equivalent to a fully franked dividend of \$11,666 for a firm with a corporate tax rate of 30%). If the investor is in a partnership or a beneficiary of a trust, both the investor and the partnership or trust must obey the rule (Australian Taxation Office, 2020g). The "related payments rule" was applied in Australia after 7:30 pm (AEST) on May 13, 1997. A related payment stands for a payment that transfers the franked dividend entitlement to someone else. The rule states that the investor who makes or is going to make a related payment has to hold the shares for at least 45 days (90 days for preference shares) to claim the franking credits (Australian Taxation Office, 2020n).

[7]See Commonwealth of Australia (1999)

Rule 4: 2000 Tax rebate for unused franking credits[8]. Before 2000, excess franking credits were wasted if the franking credits exceed the investor's tax liabilities. For example, a tax-exempt investor was unable to claim the franking credits as there is no tax liability; superannuation funds cannot utilise the excess franking credits as their franking credits are more than their tax liabilities. The tax rebate for unused franking credits was enacted in July 2000 and made the excess or unused franking credits able to be claimed by both individual investors and superannuation funds (Australian Taxation Office, 2020m). This rule creates an incentive for low taxpayers to seek franking credits (Beggs and Skeels, 2006). The effect of this rule on various investors is shown in Table 2.3.

Rule 5: 2002 SIS[9]. With the introduction of the SIS on July 1, 2002, all Australian corporate tax entities are required to convert their franking account from a "tax profit" basis to a "tax paid" basis (franking balance reported at June 30, 2002, will be converted with a conversion rate of 30/70) (The Treasury, 2002). Prior to the SIS, franking accounts were recorded on a "tax profit" basis that the franking credit balances raised from an amount that is equal to the after-tax profits. Under the SIS, franking accounts were recorded on a "tax paid" basis based on the payment or the rebate of taxes. This rule requires that taxes will be recorded in the franking account only when they are paid or received rather than accrued. For instance, dividends distributed after a firm's financial year would not be recorded in the franking account in the annual report of the current financial year. In addition, corporate tax entities are able to utilise their franking account to offset their Australian corporate tax or even obtain a cash rebate. Moreover, if the corporate entity distributes more franking credits than its franking account, it receives a penalty that is equal to the deficit.

2.2.6 Capital gains tax (CGT)

The capital gains tax (CGT)[10], introduced on September 20, 1985, in Australia by the Hawke/Keating government, was applied to capital gains from the disposal of any asset purchased on or after that date. Any asset purchased prior to September 20, 1985, is regarded as a pre-CGT asset and is not subject to CGT. Prior to September 20, 1999, an "indexation method" was implemented. The part of capital gains caused by inflation was not taxed on an asset held for more than one year, so as to eliminate taxation of inflationary gains. For assets held for less than one year or sold with a loss, indexation was not used in determining gains and losses. Twenty percent of the capital gain was included in taxable income and the calculation of the taxpayer's marginal tax rate, and all capital gains were taxed at the personal income tax rate. The "indexation method" was not used for capital gains on assets held for less than one year. CGT rules were modified by replacing

[8]See Australian Taxation Office (2020m)
[9]See The Treasury (2002)
[10]See Australian Taxation Office (2020b,o)

Table 2.4: Comparison of capital gain taxes and income taxes between individual investors and superannuation funds

The table compares capital gain taxes and income taxes between individual investors and superannuation funds before and after 1999, assuming income tax plus medicare levy is 47% for individual investors and 15% for superannuation funds, and capital gains are on assets held for at least 12 months. This table is developed for this research.

	Individual investors (before 1999)	Individual investors (after 1999)	Superannuation funds (before 1999)	Superannuation funds (after 1999)
Income tax	47%	47%	15%	15%
Capital gain tax	47%	23.5%	15%	10%

the "indexation method" with the "discount method" in 1999. The "discount method" provides a discount on capital gain taxes to both individual investors and superannuation funds to different extents. Table 2.4[11]compares the capital gain tax rate and the income tax rate between individual investors and superannuation funds before and after 1999. For individual investors (including partners in partnerships and trusts), capital gains realised within 12 months of purchase are taxed as ordinary income (with the top personal income tax rate being 47%) while capital gains on assets held for longer than 12 months are taxed at half that of ordinary income (equivalent to half of the top personal income tax rate of 23.5%). For superannuation funds, the capital gains tax (10%) is two-thirds of the income tax (with the income tax rate of superannuation funds being 15%). In addition, this special tax exemption of 50% was no longer applicable to foreign and temporary residents after May 8, 2012 (Australian Taxation Office, 2020b,o). Table 2.4 indicates that individual investors have a comparative tax advantage in capital gains over personal income compared with superannuation funds after 1999 because an individual's capital gains tax is only half of its personal income tax while a superannuation fund's capital gains tax is two-thirds of its personal income tax, even though superannuation funds has absolute tax advantages in both personal income and capital gains.

2.2.7 International imputation tax systems

According to a study by Ainsworth (2016), five countries in the Organization for Economic Co-operation and Development (OECD), namely Australia, Canada, Chile, Mexico, New Zealand, and the non-OECD member, Malta, have adopted full imputation tax systems. Korea and the United Kingdom, however, operate a partial imputation system where tax credits are less than the total amount of corporate taxes. Ainsworth (2016) also notes that several developed countries have shifted away from imputation systems. For

[11]The tax rates in Australia in 2019-2020 are used in this example. Historical capital gain tax rates and income tax rates for both individual investors and superannuation funds are shown in Table A.1 in Appendix A.

instance, the imputation tax system was implemented in Germany until 2001, Italy until 2004, Finland and France until 2005, and Norway until 2006[12].

In addition, Southeast Asian nations like Singapore and Malaysia have gone further, moving from an imputation system to a tax system where dividends are not taxed at all (Hennig, 2004; Teck, 2006). The removal achieves an even more substantial tax advantage in dividend income. Also, it should be noted that the original imputation system in Singapore and Malaysia, before being removed, significantly differed from the one in Australia in that shareholders receive a tax benefit no matter whether they are domestic investors or international investors and irrespective of whether the corporate entity has paid corporate taxes on income.

Overall, although several countries have removed the imputation tax system, the justifications of removing these systems overseas are not directly applicable to the case of Australia because there are considerable differences between Australia and these countries regarding the political and economic conditions and, more importantly, the removed imputation systems overseas are not the same as the one implemented in Australia.

2.3 Theoretical literature

This section reviews the theoretical literature that provides the basis and insight for commonly employed empirical models where the impacts of franking credits on security pricing are estimated. Franking credits are valuable in theory, but whether they are priced in the market depends on the tax status of marginal investors. Unfortunately, franking credits are not allowed to be traded in the market due to many restrictions, described in rule 3 in Section 2.2.5, designed and introduced in order to ensure treasury revenue. Therefore, there is no consensus on the market price of franking credits.

Officer (1994) proposes two parameters γ (gamma) and θ (theta) which are widely used by Australian regulators and researchers as shown in the following valuation equation:

$$MVF = X_o * \gamma/(1-\tau_c) * \tau_c = X_o * PR/(1-\tau_c) * \theta, \tag{2.1}$$

where MVF is the market price of franking credits, X_o is the operating income, τ_c is the corporate tax rate. There are three parameters within this framework. The payout ratio (PR): the percentage of a firm's after-tax net profit that has been distributed to investors as

[12] Germany shifted from the imputation tax system in January 2001 to a "half-income" system where 50% of the dividend is taxed for individuals while firms do not pay tax on dividends received. The motivation for the shift includes reducing the personal tax rate on dividends and the corporate tax rate Endres and Oestreicher (2000); OECD (2007, 2016), strengthening Germany's international competitiveness, attracting foreign investment, increasing retained earnings, and eliminating the discrimination against foreign investors based on the European Court of Justice (ECJ). Similarily, ECJ is a common determining factor contributing to the removal of the imputation system in Finland, France, Italy, and Norway (Bernstein, 2004; Graetz and Warren Jr, 2007; Hietala, 2006; Economic Review Committee, 2002; Ainsworth, 2016).

cash dividends. Theta (θ): the percentage of market value of distributed franking credits to its face value. Gamma (γ): the percentage of corporate tax that is a pre-collection of the personal income tax for the investor. θ is commonly less than one as most firms avoid distributing all of their profits to investors and re-invest part of their profit for future cash flow. γ is calculated as the product of *PR* and θ. Take an example that a firm distributes 70% of its profits to investors and all investors in that firm claim and utilise their franking credits. θ is 100% in this case; however, γ is only 70% as only 70% of corporate tax paid has been distributed to investors. γ has an upper bound of θ and it reaches the upper bound when and only when *PR* is 100% (Cannavan et al., 2004).

According to the case in Table 2.5, the company earns an operating income of $100 and pays a corporate tax of $30, thus obtaining an after-tax net income of $70. The company then distributes its income with a payout ratio (*PR*) of 70% as a cash dividend of $49 with attached franking credits of $21. The remaining $21 (e.g., the undistributed after-tax profit) would be re-invested in the firm operations. Assuming the market value of the distributed franking credits to its face value (θ) is 35%, the market price of distributed franking credits will be $7.35. Table 2.5 shows the detailed calculation of the market value of franking credits.

Table 2.5: Calculation of the market value of franking credits

This table shows the calculation of the market value of franking credits. The table assumes an operating income of $120, an interest payment of $20, a corporate tax rate of 30%, a payout ratio of 70%, a θ of 35%. All numbers in the table are in Australian dollars. This table is developed for this research based on Officer (1994).

Cash flow	General expression	Numerical example
Company level		
Operating income	X_O	120
Less interest payment	X_D	(20)
Taxable income	$X_O - X_D$	100
Less corporate tax	$(X_O - X_D)(\tau_c)$	(30)
After-tax net profit	$(X_O - X_D)(1 - \tau_c)$	70
Payout ratio	pr	70%
Cash dividend	$(X_O - X_D)(1 - \tau_c) * pr$	49
Stockholder level		
Cash dividend	$(X_O - X_D)(1 - \tau_c) * pr$	49
Franking credits	$(X_O - X_D) * pr * \tau_c$	21
Percentage of market value of franking credits	θ	35%
Market value of franking credits	$(X_O - X_D) * pr * \tau_c * \theta$	7.35

2.4 Empirical literature

The tax regulation and theoretical literature indicate that franking credits are valuable to Australian resident investors but valueless to non-resident investors because of the differences in eligibility as discussed in Section 2.2.3. Although the Australian tax authority interprets γ as the value of franking credits at the point of creation (Officer, 1994), most literature seeks to estimate the value of θ instead of γ (Cannavan et al., 2004). If all shareholders of a firm are international investors and tax-exempt, θ will be zero. On the other hand, θ will be 100% if a firm is held by only domestic tax-paying investors. However, in reality, the equity owners of most firms are a mixture of different classes of investors who value franking credits or do not value franking credits. θ thus depends on the tax status of marginal investors.

This section illustrates the empirical literature about the evidence of whether franking credits are priced or what is θ. No consensus emerges. Three main approaches, including ex-dividend drop-off studies, comparative pricing studies, and the required rate of return studies, are commonly used in the extant literature. Ex-dividend drop-off studies infer θ by comparing the price drop-off with cash dividend and franking credits on the ex-dividend date. Comparative pricing studies infer θ by comparing price differences in a pair of stocks with the same instrument but different entitlement to franking credits (e.g., underlying equity and futures). The required rate of return studies infer θ by investigating whether franking credits can reduce the required rate of return. Some other approaches, including price level studies, tax statistic studies, and franking credit balance studies, are also adopted in the extant literature. Price level studies investigate whether franking credits are incorporated in long-term share prices. Tax statistic studies examine the percentage of franking credits distributed that are utilised by Australian resident investors. Franking credit balance studies estimate the value of franking credit balance. Although there are various methodologies to estimate θ, the evidence is mixed and there is no consensus on whether franking credits are priced.

2.4.1 Ex-dividend drop-off studies

The most commonly used approach in the existing literature is ex-dividend drop-off studies. The examination is based on the theory that the dividend price drop-off on the ex-dividend date should reflect the market value of the cash dividend. Boyd and Jagannathan (1994) conclude in their paper that "over the last several decades, the one-for-one marginal price drop has been an excellent (average) rule of thumb". Under the imputation tax system, the price drop-off of a fully franked dividend should be the market value of the cash dividend and its attached franking credits. The valuation of franking credits is inferred by regressing the dividend drop-off on the cash dividend and franking credits.

2.4.1.1 Dividend ex-dividend drop-off studies

These studies originate from the debate on the existence of dividend clienteles. Miller and Modigliani (1961) first proposed the theory that a firm's dividend policy cannot affect its market value and that capital gains and dividends are of equal value to investors in a perfect market without transaction costs and taxes. That is, in their setting, the share price on the cum-dividend date is the sum of the current dividend and the present value of dividends in the future, while the share price on the ex-dividend date is the present value of dividends in the future. Therefore, the price drop-off on the ex-dividend day (the difference in share prices between the cum-dividend date and the ex-dividend date) should be equal to the amount of cash dividend in a perfectly efficient market. The equation can be expressed as:

$$E|P_c - P_e| = DIV, \tag{2.2}$$

where P_c is the share price on the cum-dividend date, P_e is the share price on the ex-dividend date, DIV is the dollar amount of cash dividend per share.

However, in an imperfect world in which taxes and transaction costs need to be considered, the conversion between dividends and capital gains cannot be costless due to the asymmetry between dividends and capital gains in tax rules, transaction costs, and other factors. These inefficiencies and imperfections might lead to clienteles. Therefore, the price drop on the ex-dividend day might not be the same as the dividend. This is supported by Campbell and Beranek (1955) and Durand and May's (1960) findings that the ex-dividend price drop is significantly less than the amount of cash dividend. An extensive literature attempts to explain why the ratio of the price drop to cash dividend per share (defined as drop-off ratio) is not equal to one.

Elton and Gruber (1970a) propose a tax explanation to account for the drop-off ratio. Elton and Gruber (1970a) claim that taxes cause the price drop-off ratio to not be equal to one and accordingly that marginal tax rates of investors can be inferred from the price drop-off ratio. Elton and Gruber (1970a) investigate the drop-off ratio of all listed firms that have paid a dividend during the period between April 1, 1966, and March 31, 1967, on the New York Stock Exchange. They provide evidence that the average drop-off ratio of US firms is less than one (around 77%) and that there is a positive relationship between dividend yields and drop-off ratios. Further, they derive an expression between the drop-off ratio and the implied tax rate for marginal investors:

$$\frac{P_c - P_e}{DIV} = \frac{1 - \tau_p}{1 - \tau_c g}, \tag{2.3}$$

where τ_p is the personal income tax rate, $\tau_c g$ is the capital gain tax rate. Their equilibrium pricing expression indicates that implied tax rates are negatively correlated with drop-off ratios. Therefore, a positive relationship between dividend yield and drop-off ratio means a negative correlation between the implied tax rates and the dividend yield. This finding provides evidence in support of Elton and Gruber's (1970a) hypothesis that firms with higher dividend yields attract more investors in relatively low tax brackets than lower dividend yield firms. Their conclusion supports a tax-induced clientele effect.

Kalay (1982) re-examines the ex-dividend events both empirically and theoretically. Empirically, the author makes adjustments to eliminate potential biases, but the drop-off ratio is still less than one, and the correlation between the price drop-off ratio and the dividend yield is still positive in the US market. The empirical results are consistent with Elton and Gruber's (1970a) findings. However, Kalay (1982) questions the taxes explanation and proposes an alternative explanation (e.g., transaction costs). He modifies Elton and Gruber's (1970a) model and finds that the drop-off ratio should fall into a no profit opportunities bound based on the assumption that no short-term traders can obtain a riskless profit by trading around the ex-dividend day shown below:

$$1-\frac{\alpha\overline{P}}{DIV} <= \frac{P_c-P_e}{DIV} = 1+\frac{\alpha\overline{P}}{DIV}, \tag{2.4}$$

where $\overline{P}=(E(P_c)+E(P_e))/2$, $\alpha\overline{P}$ is the expected transaction costs of "a round trip". This bound relies on the fact that short-term capital gains and personal income are taxed equally. Kalay (1982) adds that the drop-off behaviour evidence provided by Elton and Gruber (1970a) can also be explained by the no profit opportunity bounds and concludes that the marginal tax rate of investors cannot be inferred from the price drop-off ratio. His argument are bolstered by Ainsworth, Lee, and Walter's (2020) findings that contradicts Elton and Gruber's (1970a) tax explanation but is consistent with Kalay's (1982) transaction cost explanation by investigating the ex-dividend drop-off events in the US between 1993 and 2012.

Bali and Hite (1998) provide another plausible explanation, namely a discrete tick sizes explanation. They develop a simple model that predicts that the price drop-off should be less than the total dividend but greater than the dividend minus one tick. This model introduces a new angle using market microstructure rules to explain the drop-off. Take an example, a dividend of 30 cents is distributed, and the tick size is 12.5 cents. The expected price drop-off would be 25 cents due to the tick size restriction since no one would pay 37.5 cents for the dividend. Moreover, they regress the ex-dividend price drop-off ratio on the nearest tick price below the dividend. They fail to reject the hypothesis that the coefficient on the closest tick price below is one. They conclude that the discreteness in tick size offers a third explanation for the observed drop-off ratio behaviour in the US market. Subsequently, various microstructure issues, including bid-ask bounce, illiquidity, spreads, and order imbalances, have been investigated.

2.4.1.2 Franking credits ex-dividend drop-off studies

Under the imputation system, if both dividends and franking credits are fully priced, the price drop-off should be equal to the cash dividend and its attached franking credits as shown below:

$$E|P_c - P_e| = DIV + FC, \tag{2.5}$$

where FC is the dollar amount of franking credits per share. This becomes the premise of ex-dividend drop-off studies approach to estimate θ.

A large body of literature attempts to estimate θ in countries outside of Australia. Lakonishok and Vermaelen (1983) examine the impact of a major tax reform[13] in 1971 on ex-dividend day events in Canada. The tax reform increases the value dividends relative to capital gains through changes in franking credits and capital gain taxes. However, the price drop decreased after the implementation of this tax reform. The unexpected initial drop after the tax reform might be due to the uncertainty in the valuation of franking credits. McDonald (2001) improves Kalay (1982) and Boyd and Jagannathan's (1994) model to infer θ in and finds the evidence that the price drop-off is \$1.26 for a cash dividend of \$1 with franking credits of \$0.43. He concludes that θ is between 50% and 67% in Germany[14]. In the UK, Poterba and Summers (1984) provide evidence that a tax reform that introduced a partial imputation system in 1973 had a substantial effect on the excess return on the ex-dividend day. Bell and Jenkinson (2002) investigate the impact of a tax reform that pension funds became unable to obtain the unused imputation in July 1997 in the UK. They find that the average drop-off ratios dropped from 0.84 to 0.73 after the tax reform. Poterba and Summers (1984) and Bell and Jenkinson's (2002) findings support that franking credits are priced in the UK. Rantapuska (2008) finds evidence that domestic investors engage in overnight arbitrage by shifting from a long position to a short position around the ex-dividend date to obtain dividends and franking credits while foreign investors and tax-exempt are on the opposite side. Similarily, Chen, Chow, and Shiu (2013) and Tseng and Hu (2013) find the evidence that price drop-off increased after the introduction of the imputation system in 1998 and domestic investors engage in arbitrage around the ex-dividend date in Taiwan. Compared with Finish and Taiwan taxation law that allow investors to buy and sell stocks with franking credits on the same date, the Australia market has the holding period rule and related payment rule[15] to eliminate the direct trading of franking credits, which makes their evidence not applicable directly to the Australia imputation system.

[13] In 1971, the dividend franking credits rate was 20%, the provincial tax credit was 28%, and capital gains are not taxed. In 1972, dividends were grossed up by 33%, the franking credits rate was 20%, the provincial tax rate of the net federal tax was 30.5%, and capital gains were taxed as half of the ordinary income tax rate. Overall, a dollar of dividends worth 20% more in 1972 than that in 1971

[14] Before 2001, Germany apply an imputation system with franking credit rate of 30%. Germany removed the imputation system in January 2001 as discussed in Section 2.2.7.

[15] This is rule 3 described in Section 2.2.5.

2.4.1.3 Australian franking credits ex-dividend drop-off studies

Brown and Walter (1986) give the first insight into the Australian ex-dividend day behaviour, by providing evidence that the average price drop-off ratio is around 75% between 1973 and 1984. The evidence suggests that Australian shareholders discounted dividends relative to capital gains by around 25%. Their data are, however, drawn from periods before the introduction of the imputation system. Their findings can be used as benchmark data to examine the influences of Australian tax laws changes after 1984. They suggest further research to investigate the impacts of the imputation system on the ex-dividend price drop-off after its establishment in July 1987.

Following Brown and Walter's (1986) paper, Brown and Clarke (1993) find that the average drop-off ratio dropped rather than increased after the introduction of the imputation tax system, which coincides with Lakonishok and Vermaelen's (1983) findings in Canada, while it thereafter increased significantly after the extension of the imputation system to superannuation funds in July 1988[16]. Although the average drop-off ratio is still significantly less than one after 1987, they estimate a θ of 80%. Bellamy (1994) supports Brown and Clarke's (1993) argument that franking credits are priced by providing evidence that the average drop-off for fully franked dividends is more significant than that for unfranked dividends from 1987 to 1992. He also notes that firms that pay fully franked dividends increased their dividend payments compared with firms that pay no or little franking credits and that firms increased their dividend payments after the introduction of imputation.

Hathaway and Officer (1995) investigate the value of franking credits by regressing the price drop-off ratio on the ratio of franking credits over dividends as shown below:

$$\frac{P_c - P_e}{DIV} = \gamma_0 + \gamma_1 \frac{FC}{DIV} + \varepsilon. \tag{2.6}$$

Their findings show that the price drop-off of \$1.00 can be explained by cash dividend component (theoretical value of \$1.00) of \$0.80 and franking credits component (theoretical value of \$0.43) of \$0.20 from 1986 to 2004. This indicates a θ of 50% in the market where some investors do not place value on franking credits and some other investors place a high value on franking credits. In contrast, Beggs and Skeels (2006) use a similar regression model but come to an opposite conclusion using the same sample period. They extend Hathaway and Officer's (1995) model by applying a similar approach with the Feasible Generalized Least Square (FGLS) estimator using weights from the auxiliary regression shown below:

$$\widehat{ln\varepsilon^2} = \lambda_0 + \lambda_1 * W + \lambda_2 * G + \lambda_3 * P_c + u, \tag{2.7}$$

where ε are Ordinary Lease Squares (OLS) residuals from the last equation. Consistent

[16]This is rule 1 described in Section 2.2.5.

with the existing literature, the gross drop-off ratios are significantly less than one. However, inconsistent with Hathaway and Officer's (1995) finding that examines the same period, the franking credit drop-off ratios are insignificantly different from zero. The findings indicate that franking credits are not priced in the market if cash dividends are fully priced. Bellamy and Gray (2004) address the issue that the results of ex-dividend studies are very sensitive to the econometric models and sample selection and the market value of cash dividends and franking credits cannot be estimated respectively in the previous literature. Therefore, they argue that franking credits are worthless as cash dividends are assumed to be fully priced between 1995 and 2002 in Australia.

Following Hathaway and Officer (1995) and Beggs and Skeels's (2006) work, an extensive literature has attempted to estimate θ and provided conflicting evidence. Gray (2008) extends Hathaway and Officer (1995) and Beggs and Skeels's (2006) methodology and documents a θ of 28% from 1998 to 2006. Gray, Hall, and Costello (2011) re-examine the ex-dividend drop-off events between 2000 and 2010 and estimate a θ of 35%. Minney (2010) adjusts Bellamy and Gray's (2004) model by regressing the daily return plus the dividend yield less the return on the sector on the ex-dividend date on franking credits yield to examine θ from 2000 to 2009. Over the period, θ is 24% from 2001 to 2005 and 53% from 2006 to 2009. The author attributes the increased valuation of franking credits to the shift of marginal investors to superannuation funds who have an incentive to obtain franking credits. Feuerherdt et al. (2010) contribute to the existing literature by investigating the ex-dividend price drop-off for hybrid securities, which have higher dividend yields and are less sensitive to market returns compared with ordinary shares. The average drop-off ratios are significantly less than one. The evidence indicates that franking credits are not priced. Vo et al. (2013) argue that the estimates of θ in the previous literature are inaccurate due to the high multicollinearity between the cash dividend and the franking credits. They propose a sensitivity analysis to estimate the range of θ instead of a definite value. The findings indicate a range of θ between 30% and 55% from 2001 to 2012. Cannavan and Gray (2017) improve Hathaway and Officer (1995) and Beggs and Skeels's (2006) OLS methodology by employing a generalised least squares to reduce the inverse relationship between dividend yield and the variance of residuals from 2001 to 2016. The findings indicate a θ of 35%.

2.4.1.4 Summary of ex-dividend drop-off studies

In summary, the ex-dividend drop-off studies are the most widely used method to infer θ through regressing ex-dividend drop off against the face value of cash dividends and franking credits. However, the estimates of θ are conflicting across the existing studies. In addition, the existing literature has some limitations. Firstly, Cannavan et al. (2004) and Siau et al. (2015) address the limitation that inferring the θ from the drop-off ratio is driven more by short-term traders rather than a firm's marginal shareholders. Miller and

Scholes (1982) and Poterba (1986) point out that the estimate of the value of dividends from the ex-dividend date is a poor estimate of the value that long-term investors place on dividends. Based on this, McDonald (2001) further argues that the value of franking credits that long-term investors place on them and inferred from ex-dividend drop-off studies is also an inferior estimate. They focus on the pricing difference on specific dividend events but ignore the whole price movements in the long term. Secondly, Cannavan et al. (2004) and Siau et al. (2015) also document that noise might affect the share prices and the sample cannot represent the true population. Further, the taxation factor is not the only determinant of the ex-dividend price drop, which can be easily affected by other factors such as transaction costs (Kalay, 1982; Eades, Hess, and Kim, 1984; Lakonishok and Vermaelen, 1983; Karolyi, 1998; Bali and Francis, 2011), market microstructure (Dubofsky, 1992; Bali and Hite, 1998), and risk (Heath, Jarrow, and Morton, 1988; Grammatikos, 1989; Fedenia and Grammatikos, 1993; Michaely and Vila, 1995). Thirdly, separately identifying the value of franking credits and cash dividends is difficult econometrically (Dempsey and Partington, 2008). Bellamy and Gray (2004) and Cannavan et al. (2004) claim that the estimate of θ is poor due to multicollinearity issues between franking credits and dividends as franking credits can only be distributed when attached to dividends. Gray (2008) argues that the estimate of θ depends heavily on the assumed valuation of cash dividends (Hathaway and Officer, 1995) or coefficients generated from regression (Beggs and Skeels, 2006). Fourthly, Wood (1997) argues that the assumption that θ is constant over the sample period and across all firms is unrealistic. Lastly, Walker and Partington (1999) mention that the comparison between the ex-dividend price and the cum-dividend price is not contemporaneous because the ex-dividend price is observed on the ex-dividend date, which is typically one day after the cum-dividend date.

2.4.2 Comparative pricing studies

The second stream of literature is comparative pricing studies. These studies examine θ by comparing prices of one pair of stocks that are the same in their underlying but only differ in dividends and their entitlement to franking credits (franking credits are received in one asset but not in another asset).

The first method that has been developed is the contemporaneous comparison between the cum-dividend shares and ex-dividend shares. As discussed above in Section 2.4.1.2, ex-dividend drop-off studies are limited by the non-contemporaneousness between the cum-dividend shares and ex-dividend shares (Walker and Partington, 1999). The fact that the Australian Stock Exchange (ASX) allows investors to trade cum-dividend shares during the ex-dividend periods provides researchers with a natural environment to compare the cum-dividend shares and ex-dividend shares contemporaneously. This is due to the fact that the book closure date[17] happens five business days after the ex-dividend date. Walker and Partington (1999) infer the combined value of franking credits and dividends by comparing the cum-dividend shares during the ex-dividend period and ex-dividend shares from January 1995 to March 1997 and find that the instantaneous drop-off ratio is 1.23, which can reject the null hypothesis that drop-off ratio is equal to one. Their findings indicate that θ is around 90%.

The most commonly used methodology in the comparative pricing studies is the comparison between the underlying and their derivatives. McDonald's (2001) extracts franking credits by comparing DAX 30 index and DAX 30 index futures. The author finds a θ between 65% and 89% in futures price before 1994, and 65% afterwards. Twite and Wood (2003) conduct similar research to estimate a θ of 45% by comparing Individual Share Futures contracts (ISFs) with their underlying from 1994 and 1995. Cannavan et al. (2004) extend McDonald's (2001) equilibrium model by relating the valuation of franking credits to the price of the derivatives (ISFs) or Low Exercise Price Options (LEPOs) in Australia. They find that the holding period rule and the related payments rule[18] introduced in 1997, devised to prevent the purchase and selling of franking credits, affects the value of tax credits. θ is around 50% before 1997 but subsequently drops to zero. However, Cummings and Frino (2008) find contradictory results by inferring θ from the comparison of the index futures prices and their underlying securities during the period from 2002 to 2005 and find a θ of 52%.

An alternative methodology is comparing the prices between the underlying stocks and their ADRs that are mainly held by US investors who are unable to claim the franking credits. Jun, Alaganar, Partington, and Stevenson (2008) and Jun and Partington (2014) propose this approach by comparing the prices on the ex-dividend date between the underlying stocks in Australia and their ADRs. Jun et al. (2008) find that the ex-dividend drop is lower for ADRs than their underlying, especially for those securities with franking credits. Jun and Partington (2014) document that the pricing of Australian ADR dividends is less than its par value, but the pricing of underlying stocks is higher than its par value and attribute the pricing differences to the franking credits. Their findings indicate that θ is from 15% to 25% in the market. Besides, the merger between Conzinc Riotinto of Australia (CRA) in Australia and Rio Tinto – Zinc (RTZ) in the UK provides Chu and Partington (2008) a natural environment to infer θ by comparing the price difference between bonus shares with franking credits and old shares without franking credits. They find that shares carrying franking credits tend to have a higher market value than those without franking credits. The premium of market value over face value disappears when the stock goes ex-dividend.

[17]The book closure date is the cut-off date that determines whether investors are able to claim the dividend.

[18]This rule is rule 3 described in Section 2.2.5.

In summary, the most popular methodology in comparative pricing studies is to infer θ by comparing underlying stocks and their derivatives. They overcome some mentioned issues in ex-dividend studies such as the noise and market microstructure effects (Kalay, 1982; Lakonishok and Vermaelen, 1983; Eades et al., 1984; Karolyi, 1998; Cannavan et al., 2004; Siau et al., 2015), non-contemporaneous comparison between the cum-dividend shares and ex-dividend shares (Walker and Partington, 1999) and the difficulty to separate dividends and franking credits (Bellamy and Gray, 2004; Cannavan et al., 2004) described in Section 2.4.1.4. However, there are still some limitations. Firstly, the estimate of the valuation of franking credits from derivatives might be poor. McDonald (2001) and Cannavan et al. (2004) document that transaction costs in futures contracts including brokers' commission fees, administrative, monitoring and set-up costs prevent certain investors from investing in futures contracts and that this leads to different marginal investor bases between underlying and futures contracts. Therefore, comparing prices between derivatives and their underlying is misspecified and might produce poor estimates for marginal investors (Lajbcygier and Wheatley, 2012). Secondly, like ex-dividend studies, the comparative pricing studies also focus on the price differential around specific ex-dividend events but ignore the overall pricing movement in the long term (Siau et al., 2015).

2.4.3 The required rate of return studies

The third stream of literature estimates the value of franking credits by relating the required rate of return with franking credits. This methodology is based on the theory that franking credits should reduce the required rate of return (Officer, 1994). However, whether franking credits lower the required rate of return in practice depends on the identity of marginal investors. Lajbcygier and Wheatley (2012) claim that "the impact of credits on the returns that investors require on equity will depend to a large extent on whether equity markets are segmented or – aside from an inability of foreign investors to redeem credits – integrated". More specifically, if the equity markets are independent of the international market, franking credits can reduce the required rate of returns as the marginal investors are more likely to be domestic investors. In contrast, if the equity markets are integrated with the international market, franking credits cannot reduce the required rate of returns as the returns of a small open economy are dominated by international investors who do not value franking credits at all. Researchers in the required rate of return studies estimate the value of franking credits by regressing cross-sectional risk-adjusted returns on risk-adjusted franking credits yield.

The traditional Capital Asset Pricing Model (CAPM) (Sharpe, 1964; Lintner, 1965) assumes that taxes on capital gains and dividends are the same. However, Officer (1994) argues that the assumption is invalid as under an imputation system taxes on dividends are lower than those on capital gains and investors receive a higher cash flow due to the franking credits. He derives an amended version of CAPM[19] in which weighted average cost of capital (WACC) incorporates franking credits under Australian dividend imputation system.

$$E(r'_{jt}) = r_{ft} + \beta_j[E(r_{mt} + \tau_{mt}) - r_{ft}], \tag{2.8}$$

where $E(r'_{jt})$ is the expected return after company tax before personal tax, $E(r_{mt})$ is the expected return on the market portfolio, τ_{mt} is the valuation of franking credits in the market portfolio, r_{ft} is the risk-free rate. Officer's (1994) version of CAPM is widely applied by Australian regulatory authorities.

Wood (1997) extends Monkhouse's (1993) model by replacing multiple investors with two groups of investors who can either (i) utilise franking credits or (ii) who cannot and finds an estimate of θ of 60%. Faff, Hillier, and Wood (2000) provide indirect evidence to the extant literature by noting that the slope between beta and return is steeper after the introduction of the imputation system in 1987 in Australia. In particular, assuming that dividend yield is negatively correlated with the risk, the beta is positively related to returns. They attribute the increase of risk premium to franking credits by employing an "imputation-adjusted CAPM" and conclude that franking credits are capitalised in the market.

Lajbcygier and Wheatley (2012) investigate the relation between risk-adjusted equity returns and risk-adjusted credit yields by applying five models (the CAPM, the international CAPM, the Fama-French two-factor models, the Fama-French three-factor model and the Chen-Novy-Marx-Zhang (CNMZ) alternative three-factor moded) using monthly data from 1987 to 2009 and find no evidence that franking credits cannot reduce the required rate of return. More specifically, the authors first estimate the risk each month using the data of the previous 60 months and calculate a security's franking credit yield. They find no relationship or even a positive relationship rather than a negative relationship between equity returns and franking credit yield across all models, regardless of whether they use models that assume segmented markets or integrated international markets.

2.4.4 Other studies

Price level studies investigate the influence of franking credits on long-term price levels. The central hypothesis is that if franking credits are priced in the market, the pricing levels of securities with franking credits will be higher (Officer, 1994; Dempsey and Partington, 2008). Siau et al. (2015) examine θ by investigating the impacts of franking credits on price levels under Gordon and Gordon's (1997) discounted cash-flow (DCF) valuation model with input from forecasts and Ohlson's (1995) clean surplus accounting model

[19] Monkhouse (1993), Wood (1997), Lally (2000), Lally and Van Zijl (2003), and Dempsey and Partington (2008) also conducts similar research and develop different versions of CAPM.

for 468 listed securities from 1996 to 2011. Their overall findings fail to uncover any relationship between franking credits and pricing levels.

Tax statistics studies investigate the valuation of franking credits from tax statistics. Some researchers (Handley and Maheswaran, 2008; Hathaway, 2013) examine the utilisation ratio of franking credits (the percentage of franking credits used by Australian resident investors in franking credits received by investors) using tax statistics from the annual ATO publication. Handley and Maheswaran (2008) find that the utilisation ratio of franking credits that have been claimed by investors is 67% from 1990 to 2000 and 81% from 2001 to 2004. They attribute the increase to the tax rebate for unused franking credtis[20]. Hathaway (2013) updates the utilisation ratio to 68% using tax-statistic data from 1988 to 2011; the author raises his concerns that θ and γ are unclear using the tax-statistic data.

Dividend reinvestment plan (DPR)[21] studies relate firms' decision to utilise DPR with franking credits. Firms are more likely to utilise DPR after the introduction of franking credits in 1987 (Chan, Mccolough, and Skully, 1995) and even more after the introduction of a cash rebate of unused franking credits in 2000 described in rule 4 in Section 2.2.5 (Abraham, Marsden, and Poskitt, 2015b). The relationship between utilisation of DPR and the level of franking credits is positive in financial firms (Abraham et al., 2015b) but negative in non-financial firms (Abraham, Lau, and Marsden, 2019). Following Chan et al. (1995) and Abraham et al.'s (2015b) work, Abraham, Dempsey, and Marsden (2015a) propose a tax-explanation that DRP reduces the cost of capital of firms to the increasing utilisation of DPR after 1987 and 2000.

Another stream of studies examines the significance of franking credits on dividend policy. Balachandran and Nguyen (2018) find that the post-Kyoto [22] reduction in dividend payout ratio is lower for companies under an imputation environment than those under a classical tax system. Balachandran, Khan, Mather, and Theobald (2019) add that firms operating under an imputation tax system are more likely to pay a dividend and have a higher payout ratio.

Franking credit balances studies provide a new angle by examining the pricing of franking account balances. This methodology is based on the assumption that if franking credits are priced in the market, franking credit balances should also be priced by investors. Heaney (2009) uses a sample of firms that report franking credit balances in their annual report on ASX between 2001 and 2006. He applies fixed effects panel analysis and uncovers evidence that investors in small companies place a higher valuation of franking credits than those in larger companies. In addition, larger companies are more inclined

[20]This is rule 4 described in Section 2.2.5.

[21]A DPR enables investors to reinvest their dividends in newly issued shares without transaction costs (Dammon and Spatt, 1992).

[22]The Kyoto Protocol is an international agreement that commits state parties to reduce greenhouse gas emissions to meet national reduction targets

to accumulate franking credit balance than smaller companies. However, this estimate is poor due to his lack of ownership data.

There are some other studies that document direct or indirect evidence on the impact of franking credits on the Australian equity market. Balachandran and Nguyen (2004) find evidence that the price reaction to the announcement of special dividends are not statistically different between fully franked dividends and unfranked dividends.

2.5 Conclusions

This chapter introduces the Australian tax system and reviews both theoretical and empirical literature that investigate the market pricing of franking credits. Although franking credits are valuable to Australian resident investors in theory, the evidence on the estimates of the θ in the extant literature is mixed and remains broadly disputed due to a variety of methodological approaches, each of which has different estimation limitations. Whether franking credits are priced in the market is debatable. This thesis contributes to the literature by providing empirical evidence to answer this question, as well as addressing some of the limitations mentioned above, in the following three chapters. Each chapter provides empirical evidence from a study of different aspects of the market pricing of imputation credits.

Chapter 3

The Curious Case of A Price Premium between BHP and Billiton ADRs

3.1 Introduction

BHP Group was formed in 2001 when the Broken Hill Proprietary Company Limited in Australia merged with the Anglo–Dutch Billiton Plc in the United Kingdom (UK) to form a Dual-Listed Company (DLC). A DLC (also referred to as a "Siamese twin") is a structure where two firms contract to combine their management teams, operations, and cash flows while retaining separate shareholding identities and stock exchange listings. In this case, BHP Group Limited (BHP) and BHP Group Plc (Billiton)[1] share the same board of directors, operations, and dividends, while BHP is primarily listed on the Australian Securities Exchange (ASX) and Billiton is primarily listed on the London Stock Exchange (LSE)[2]. The equalisation ratio between BHP and Billiton is one to one. In addition, BHP and Billiton are cross-listed on the New York Stock Exchange (NYSE) as BHP Group Limited American Depositary Receipts (ADRs) and BHP Group Plc ADRs, which are referred to as BHP ADRs and Billiton ADRs respectively. In fully integrated and efficient financial markets, even though the underlying company is listed on different exchanges, the two ADRs should have the same price because both securities receive the same US dollar denominated dividends and have the same voting rights. However, the evidence indicates that there is a significant and substantial premium for the BHP ADR over the Billiton ADR that is regarded as an anomaly to the market efficient theory (Barberis and Thaler, 2003).

Following Rosenthal and Young (1990) and Froot and Dabora's (1999) claim that stock prices are influenced by the trade location, a considerable body of literature attempts to identify factors that might explain price differences between DLCs twins. For the mis-

[1]BHP Billiton Limited and BHP Limited Plc changed their names to BHP Group Limited and BHP Group Plc effectively on November 19, 2018.

[2]BHP Group also has a secondary listing on the Johannesburg Stock Exchange.

pricing between the BHP twins, Su et al. (2013) investigate several economic differences (between Australia and the UK), including currency risk, gross domestic product (GDP), the unemployment rate, the inflation rate, the consumer price index (CPI), the official cash rate (ORC), national current account, imports, exports, government debt, business confidence, and 10-year government bonds. As a general conclusion, the empirical research to date indicates that the mispricing between the BHP twins cannot be arbitraged away, and no one individual factor is sufficient to fully explain the empirically observed time variation in the premium (De Jong et al., 2009; Su et al., 2013).

This chapter investigates the role of taxation differences in the dividend franking credit arrangements (i.e., the extent to which the dividend imputation system is more complete in Australia than it is in the UK)[3] and the top marginal personal dividend tax rate differences between Australia and the UK in the mispricing of the BHP twins. Our empirical investigation focuses on the premium to the ADRs rather than the underlying assets since both ADRs are denominated in US dollars and both securities trade in the same time zone. Accordingly, this chapter does not need to consider exchange rate risk and possible lead-lag information effects addressed by Copeland and Copeland (1998) and Bedi et al. (2003) in comparing the share prices of the ADRs. The central research design investigates the hypothesis that tax differentials significantly explain (both statistically and economically) the pricing differences between the BHP and the Billiton ADRs. This chapter applies two multivariate ordinary least squares (OLS) linear regressions to test this hypothesis. The first regression investigates the direct relationship between price divergences and tax rate differences due to franking credits and personal taxes. The second regression uses the relative price differences between BHP and Billiton ADRs as the dependent variable with the main independent variable being the relative differences in estimated prices using the Gordon Growth Model (GGM) derived by Gordon and Shapiro (1956) and Residual Income Model (RIM) derived by Ohlson (2001) to value the after-tax dividend streams of both ADR holders. Our findings indicate that differences in the tax systems between Australia and the UK, especially dividend imputation tax credits, are a significant factor in explaining this premium between the BHP twins.

This chapter makes four main contributions to the literature. First, this chapter uses tax factors to explain the mispricing between the BHP twins while the literature about BHP mispricing is limited (Froot and Dabora, 1999; Bedi et al., 2003; De Jong et al., 2009; Su et al., 2013). Second, the study in this chapter shifts from analysing DLC twins to the comparison between their counterpart twin ADRs to remove the effect of timezone difference and exchange rate risk addressed by previous literature (Copeland and Copeland, 1998; Bedi et al., 2003). Third, by proposing the new approach that compares the prices of two instruments which are same in their underlying but differ in their entitlement to

[3]As will be explained below in more detail, Australia has an almost "full" imputation system, while the UK has a "partial" imputation system.

franking credits (i.e., ADRs of DLC twins), this chapter extends the comparative pricing studies (McDonald, 2001; Cannavan et al., 2004; Chu and Partington, 2008; Jun and Partington, 2014) reviewed in Section 3.2.4. Finally, this chapter provides direct evidence to the debate that whether franking credits are priced in the market discussed in Section 2.4.

The remainder of this chapter is organised as follows. Section 3.2 provides evidence on the mispricing and briefly reviews the related literature and describes the main differences in the dividend imputation tax systems between Australia and the UK. Section 3.3 elaborates the research hypotheses and the objectives of this study. Section 3.4 and Section 3.5 describe the data collection and research methodology. Section 3.6 presents the results, and Section 3.7 concludes and discusses the original contribution of this research.

3.2 Literature review

This literature review consists of four parts. Section 3.2.1 provides a brief background of the merger between BHP and Billiton. Section 3.2.2 contains literature related to investigating price differences of the underlying assets and their ADRs. Section 3.2.3 focuses on studies about price differences between ADR twins. Section 3.2.4 reviews the literature of comparative pricing studies.

3.2.1 The background of the BHP and Billiton merger

BHP Group is a leading global resources company and is well known to investors all over the world. BHP Group, formerly known as BHP Billiton, was formed when the Broken Hill Proprietary Company Limited in Australia merged with the Anglo–Dutch Billiton plc in the UK on June 29, 2001, creating the world's leading diversified resources group. BHP is the second Australian company entering into a DLC structure[4]. As mentioned above, a DLC is a corporate structure where two companies combine their operations and cash flows through an equalisation agreement but retain separate shareholder identities and stock exchange listings. The DLC structure means that BHP and Billiton separately maintain their listings on ASX and LSE. However, both companies share the same board of directors. The equalisation ratio is one to one, which means that one share bought on ASX or LSE should have the same economic value because they have the same dividend streams and have equal voting rights. However, this expectation is not empirically supported. From Fig. 3.1, BHP in Australia has traded at a premium compared with Billiton in the UK for most of the last decade. It is also clear from Fig. 3.1 that there is consid-

[4]The first DLC in Australia is Rio Tinto Group, which is a British-Australian international metals and mining company with the head office in the UK and a management office in Australia. In 1995, The Rio Tinto – Zinc Corporation (RTZ) and Conzinc Riotinto of Australia (CRA) merged into a DLC with separate management and a one to one equalisation ratio. Rio Tinto Group is listed on the LSE as Rio Tinto Plc and the ASX as Rio Tinto Limited. However, Rio Tinto Group does not have ADR twins.

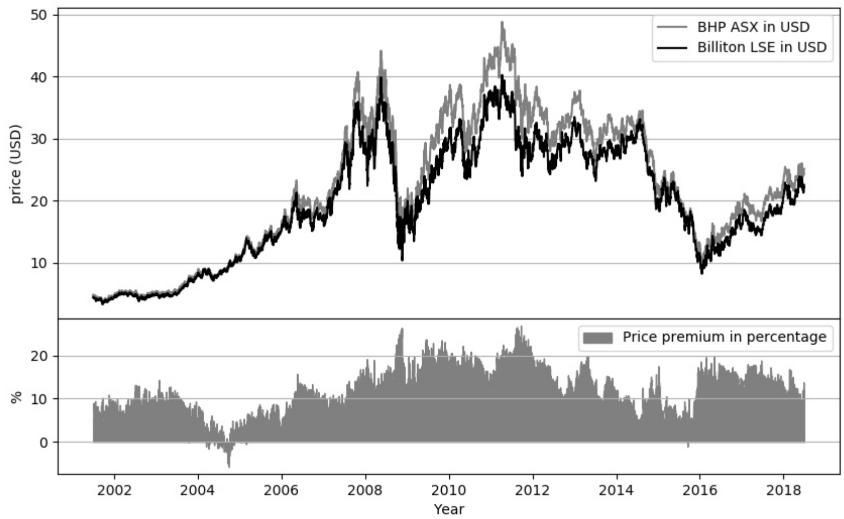

Fig. 3.1. The figure plots the prices of BHP on ASX and Billiton on LSE (in USD) during the period from June 30, 2001 to June 30, 2018. Share price data are collected from Bloomberg after adjusting for exchange rates to USD.

erable variation through time in the size of this premium and that there have been some, albeit limited, periods where BHP shares traded at a price below Billiton. The price difference between the BHP twins is referred to as the mispricing. The mispricing between DLC twins is usually regarded as an anomaly to the market efficiency theory (Barberis and Thaler, 2003).

Why is there a substantial price premium between BHP on ASX and Billiton on LSE? Before answering this question, another question as to why there is no instantaneous arbitrage opportunity between these twin securities needs to be addressed because if the price premium can be arbitraged, the price premium will not persist. However, these twin securities are not exchangeable. Specifically, an investor cannot buy a share of BHP on ASX and sell it directly on LSE to implement an instantaneous riskless arbitrage strategy (Bedi et al., 2003). Returning to the original question, possible explanations for the premium between BHP and Billiton are exchange rate risk (Copeland and Copeland, 1998; Bedi et al., 2003) and different trading time zones (Su et al., 2013). BHP ASX is traded in Australian dollars, and Billiton LSE is traded in British pounds. In addition, the trading session on ASX is earlier than LSE, and there is no overlapping trading period between ASX and LSE. According to evidence provided by Su et al. (2013), a cross-listed company spillover effect flows from the earlier time zone market (ASX) to the later time zone market (LSE). To resolve this currency and timezone issue, this chapter moves the focus (see Section 3.2.2) from the underlying assets to their ADRs. This chapter first demonstrates that there is an almost perfect mapping from BHP (and Billiton) to their US ADRs.

3.2.2 BHP, Billiton and their respective ADRs

ADRs are negotiable receipts issued by a bank to represent a specified number of the underlying stocks of a non-US company. The ADR ratio is defined as the number of non-US shares represented by a single ADR. The ADR ratio for BHP ADR and Billiton ADR is two. It indicates that one BHP ADR represents two shares of BHP on ASX, and one Billiton ADR represents two shares of Billiton on LSE. ADRs provide US investors with opportunities to trade non-US securities without having to invest directly overseas and hence shield US investors from currency risk. Although Hong and Susmel (2003) and Barberis and Thaler (2003) show arbitrage opportunities between prices of the underlying and their ADRs, most literature arrives at the conclusion that there is no opportunity to profit through arbitrage between underlying assets and their ADRs. As shown by Bedi et al. (2003), the price premium between ADRs and their underlying security is negligible because they are fully fungible (convertible), and hence any premium would have already been eliminated by arbitrage. Any small price difference between an underlying asset and its ADR is most likely related to transaction costs and asynchronous price observations. This is consistent with early evidence provided by Kato, Linn, and Schallheim (1990), Park and Tavakkol (1994), Miller and Morey (1996) and Karolyi (1998) who find there are no arbitrage opportunities between underlying assets and their ADRs. Koumkwa and Susmel (2008) extend these studies by demonstrating that price spreads between underlying assets and their ADRs reduce by more than 50% in two business days when using a non-linear adjustment model. Some studies posit other reasons to explain the price spreads. Hsu and Wang (2008) investigate a sample of 37 ADRs in China, Hong Kong, Japan, Singapore, Korea, and Taiwan from 1993 to 2006 and attribute the price spreads between underlying stocks and ADRs to heterogeneous expectations, which is assumed to be measured by trading volume and macroeconomic events. Grossmann, Ozuna, and Simpson (2007) apply a fixed-effects panel data model and show that ADR mispricing is more severe when transaction costs (bid-ask spread) are higher, dividend payments are lower, or the T-bill interest rate is higher. Other possible explanations for the mispricing between underlying assets and their ADRs are exchange rate risk, different trading time zones, and transaction costs.

Overall, the review of the relevant literature suggests that the price difference between underlying assets and their ADRs should be close to zero. The rest of this section presents an empirical comparison of the prices between BHP on ASX and Billiton on LSE and their ADRs on NYSE. Fig. 3.2 and Fig. 3.3 below show that, compared with the price divergence between DLC twins in Fig. 3.1, the spread between the underlying stock and its respective ADRs on NYSE is much smaller. Arbitrage activities ensure this very close relationship in prices, because each ADR represents exactly two units of the underlying stock. The remaining spread between the underlying assets and their respective ADRs can

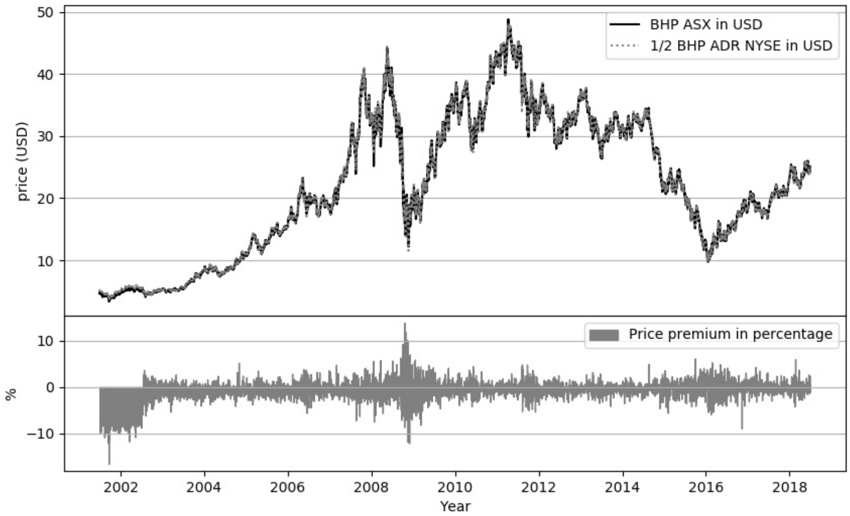

Fig. 3.2. The figure plots the prices of BHP on ASX and half BHP ADR on NYSE (in USD) during the period from June 30, 2001 to June 30, 2018. Share price data are collected from Bloomberg after adjusting for exchange rates to USD.

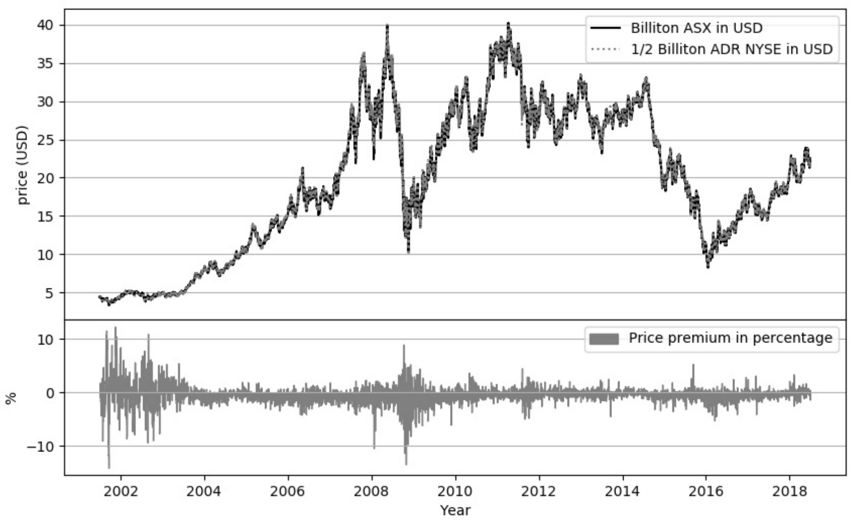

Fig. 3.3. The figure plots the prices of Billiton on LSE and half Billiton ADR on NYSE (in USD) during the period from June 30, 2001 to June 30, 2018. Share price data are collected from Bloomberg after adjusting for exchange rates to USD.

Table 3.1: Regression of daily shares prices of BHP and Billiton on half of their ADRs

This table shows estimated coefficients, standard errors and R-squared from OLS regressions of the daily share price of BHP and Billiton on half of the daily price for their respective ADRs for the period from June 30, 2001 to June 30, 2018.

	$BHP_t = \beta_1 \times BHP\ ADR_t + \varepsilon_t$	$Billiton_t = \beta_1 \times Billiton\ ADR_t + \varepsilon_t$
β_1	1.003	0.998
R^2	99.90%	99.94%

be attributed to differences in time zone and currency exchange rate uncertainties. While the ADRs can be directly exchanged for the underlying stocks, BHP shares, and Billiton shares are not directly exchangeable. Hence the premium between the two underlying securities can be substantial.

This chapter regresses the daily prices of BHP and Billiton on the prices of a half share of the BHP ADR and Billiton ADR (because an ADR represents two units of the underlying stock) respectively for the period from June 30, 2001 to June 30, 2018. Table 3.1 demonstrates the fact that BHP and Billiton prices and their respective ADRs trade at almost the same price. This finding is consistent with the generally accepted view from prior empirical studies that price differences between underlying assets and their ADRs are close to zero. In addition, the slight divergences in Table 3.1 between the underlying assets and their ADRs can be ascribed to time-zone differences[5] and foreign exchange risk.

3.2.3 The pricing of BHP ADR and Billiton ADR

As shown in Fig. 3.2 and Fig. 3.3 above, the prices of BHP (Billiton) and its ADR are almost the same. Consistent with Fig. 3.1, Fig. 3.4 indicates that the price differentials between the ADR twins still exist. There is still a substantial price premium between the ADR twins. As there is no time zone difference or exchange rate risk, there must be other fundamental factors that contribute to the mispricing. Traditional finance theory hypothesises that the equity price is unrelated to the trading location if international financial markets are perfectly integrated. A significant body of literature attempts to explain the price divergences between cross-listed stocks or dual-listed stocks. Rosenthal and Young (1990), Bodurtha Jr, Kim, and Lee (1995) and Froot and Dabora (1999) first present the idea that stock prices are influenced by the trade location since each "twin stock" has a strong correlation with the market in which it is traded. Their conclusion indicates that international markets are partially segmented, and share prices are significantly influenced by country-specific investor sentiment. So, according to Rosenthal and

[5] ASX is traded from 00:00 UTC to 06:00 UTC, LSE is traded from 08:00 UTC to 16:30 UTC, and NYSE is traded from 14:30 UTC to 21:00 UTC.

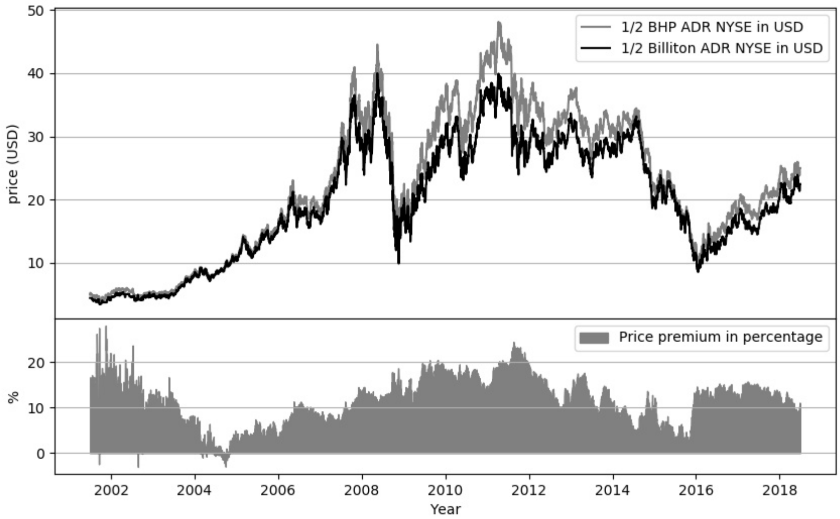

Fig. 3.4. The figure plots the prices of half BHP ADR on NYSE and half Billiton ADR on NYSE (in USD) during the period from June 30, 2001 to June 30, 2018. Share price data are collected from Bloomberg.

Young (1990), Bodurtha Jr et al. (1995) and Froot and Dabora's (1999) arguments, BHP's price on the ASX would increase when the Australian market is rising. However, Rosenthal and Young (1990) and Froot and Dabora (1999) do not provide specific underlying factors that cause location differences.

Following the influential work of Rosenthal and Young (1990) and Froot and Dabora (1999), an increasing body of literature reports evidence on the impediments to arbitrage. Rosenthal and Young (1990), Bodurtha Jr et al. (1995) and Froot and Dabora's (1999) idea are bolstered by Chan, Hameed, and Lau (2003), Barberis, Shleifer, and Wurgler (2005) and Greenwood and Sosner (2007) who all agree that the pervasive price divergences between DLC twins or cross-listed companies should be attributable to the location of trade, investors' sentiment, and the manner of trading. Chan et al. (2003) examine price movements after the trading location of the Jardine Group companies moved to Singapore from Hong Kong. They provide evidence that Jardine Group share prices become less correlated with the Hong Kong market and more correlated with the Singapore market after the move. Barberis et al. (2005) apply a univariate analysis and find that stocks experience considerable growth in beta after being added to the S&P 500 index and a significant fall in beta after being deleted from the S&P 500 index. The replacement of 30 stocks in the Nikkei 225 Index in April 2000 offered Greenwood and Sosner (2007) a natural experiment for uncovering a large increase in the correlation of trading volume of added stocks and stocks remaining in the Index. What are other possible factors? Copeland and Copeland (1998) claim that the exchange rate is a significant explanatory factor of the country return by investigating the Dow Jones global industry indices. You, Parhizgari, and Srivastava (2012) find that market trading volume has a significant impact on increasing market efficiency. However, the previous literature does not provide sufficient evidence that fundamental factors such as currency risk, liquidity, and tax factors can fully explain the price premium. There is no direct research on the mispricing between the ADR twins. Although some literature investigates the mispricing between their underlying twins, the possible reasons for the price premium are complex and, to date, somewhat illusive (Bedi et al., 2003; De Jong et al., 2009; Su et al., 2013). Bedi et al. (2003) extend Froot and Dabora's (1999) work by demonstrating the existence of ongoing price differentials in 14 DLC twins including BHP and Billiton. They suggest that some DLC twins are not convertible into each other and thus attribute the mispricing to the lack of exchangeability between the assets, instead of fundamentals, such as liquidity differences and taxation factors. More specifically, since investors cannot directly convert a BHP share on ASX to Billiton share on LSE, a BHP ADR cannot be directly converted to a Billiton ADR on NYSE. The ADRs are distinctly different stocks. Investors cannot expect a riskless arbitrage profit through taking a long position in Billiton ADR and a short position in BHP ADR. Although the lack of exchangeability explains why there is no riskless arbitrage opportunity, it does not explain the mispricing. De Jong et al. (2009) examine price differences in a sample of 12 DLC twins, including BHP Group, Royal Dutch/Shell, Unilever, ABB, and other companies from 1980 to 2002. They implement an arbitrage strategy with an abnormal return of 10% based on the assumption that price premium will converge by considering brokerage commission fees, bid-ask spread, short-sale constraints, and capital requirements. However, they find that the annual idiosyncratic volatility is more than 30% and the daily value at risk is around -4%. Their main conclusion is that uncertainty in convergence dates and idiosyncratic risk impede the operation of arbitrage. Su et al. (2013) regress the premium between BHP ASX and Billiton LSE on many fundamental factors, including currency risk, the particular stock index selected, GDP, the unemployment rate, the inflation rate, CPI, ORC, national current account, imports, exports, government debt, business confidence, and 10-year government bonds from 2001 to 2011 and report that there is no strong evidence to indicate that BHP and Billiton prices are converging and that no single fundamental factor can fully explain the price differences.

This chapter hypothesises that tax factors are responsible for this premium. Bedi et al. (2003) however argue that tax factors do not explain the price differences of 12 DLC twins since marginal investors might be foreign investors. Froot and Dabora (1999) report that tax-induced investor heterogeneity cannot explain all the price spreads for three DLC twins: Royal Dutch Petroleum and Shell Transport and Trading PLC; Unilever N.V. and Unilever PLC; and SmithKline Beecham and Beecham Group. Graham (2013) maintains that security returns are affected by personal taxes. He cites several papers to support his argument including (i) Auerbach (1983) who points out that certain investors pick stocks according to firm-specific dividend-price ratios due to tax-related clientele preferences, (ii) Constantinides (1983) and Dammon, Spatt, and Zhang (2001) who argue that capital gains taxes influence investors' investment and consumption decisions, and (iii) Seida and Wempe (2000) who suggest that investors are more likely to realise their capital gains and are reluctant to realise their capital losses when the capital gains tax rate increased with the passage of the 1986 Tax Act. In addition, McGrattan and Prescott (2005) suggest that the effective marginal tax rate on dividends is negatively correlated with the value of the stock market by providing evidence that the total value of corporations doubled from 1960 to 2000 due to the decrease of the effective marginal tax rate. This evidence suggests that tax rates might play an important role in pricing equities. Accordingly, tax differences between Australia and the UK might contribute to the price divergences between BHP and Billiton ADRs. The evidence on whether the pricing of ADRs is determined by tax rules in the US is conflicting. Jun et al. (2008) and Jun and Partington (2014) find that the ex-dividend drop-off is smaller for ADRs than underlying stocks in Australia due to the high cum-price in Australia relative to that in ADRs and argue that the prices of ADRs are affected by US tax rules rather than Australian taxes. However, Kadapakkam, Meisami, and Shi (2010) show a contradictory finding that the ex-dividend price drop is equal to the dividend, which indicates that the prices of ADRs are affected by tax policy in the home market, rather than the US. This chapter provides evidence on whether the prices of ADR are affected by the tax rules of the home market. These differences in taxes between Australia and the UK will be discussed in Section 3.2.5.

3.2.4 Comparative pricing studies on the valuation of franking credits

As discussed in Section 2.4.2, comparative pricing studies extract the value of franking credits by comparing prices of one pair of stocks that are the same in their underlying but only differ in dividends and their entitlement to franking credits (franking credits are received in one asset but not in another asset). This chapter extends the comparative pricing studies (McDonald, 2001; Cannavan et al., 2004; Chu and Partington, 2008; Jun and Partington, 2014) by proposing the new approach that compares the prices of two instruments which are same in their underlying but differ in their entitlement to franking credits (i.e., ADRs of DLC twins).

3.2.5 The role of tax differences

As discussed in Chapter 2.2, Australia changed the tax system, moving from the classical tax system to the imputation tax system with the ultimate objective of eliminating the double taxation of corporate earnings after July 1, 1987. From 1973 to 1999, the

UK was operating under an imputation system in which shareholders are able to obtain franking credits that are equal to the corporate tax. After April 1999, the franking credit rate decreased from 20% to 10%, and there is no refund of unused franking credits. Although both Australia and the UK have imputation systems, they are quite different in their details. Table B.1 and Table B.2 in Appendix B provide historical corporate tax rate, franking credit rate and top marginal personal income tax rate in Australia and the UK from 2001 to 2018.

Although the cash dividends paid to shareholders are the same for BHP and Billiton (and their ADRs), the franking credit rates and the personal dividend tax rates are different between Australia and the UK. For example, in 2018, the franking credit rate is 30% in Australia, whereas it is 10% in the UK. Similarly, the top marginal personal dividend tax (plus a Medicare levy of 2%) is 47% in Australia while it is 38.1% in the UK. These differences in the taxation system, as well as differences in the corporate tax rates, cause a difference in the net (after-tax) dividend. This is hypothesised to cause investors to arrive at different present values for the future dividend streams of the two securities. Table 3.2 compares the cash flows from the company to shareholders between BHP and Billiton in the financial year 2017-2018. It shows that BHP shareholders receive a net dividend of \$53 which is 7% higher than the net dividend of \$49.52 obtained by Billiton shareholders.

Table 3.2: Comparison of cash flows and the effective rate from the company to investors between BHP ASX and Billiton LSE

The table reports the differences in cash flow from the company to investors through cash dividends between BHP ASX and Billiton LSE in 2018. The table assumes a personal dividend tax rate (plus a 2% of Medicare levy) of 47% in Australia and 38.1% in the UK. BHP and Billiton share the same cash dividend of \$70. All numbers in the table are in US dollars.

Cash flow	BHP shareholder	Billiton shareholder
Company level		
Cash dividend	70	70
Stockholder level		
Cash dividend	70	70
Franking credits	30	10
Gross dividend	100	80
Personal Tax Rate	47%	38.1%
Personal tax liability	(47)	(30.48)
Franking credit offset	30	10
Net tax payment	(17)	(20.48)
Net (After-tax) dividend	53	49.52
The effective rate	24.29%	31.22%

3.3 Research hypothesis

According to efficient market theory, and in the absence of tax distortions, the share prices of the ADR twins should be the same because they have identical US-dollar denominated dividend payments. Although several researchers have attempted to find fundamental factors contributing to the different pricing of the ADR twins, no existing research explains why there is a substantial premium for the BHP securities. Some research has drawn attention to tax differences as a possible explanation (Bedi et al., 2003; Froot and Dabora, 1999). Bedi et al. (2003) claim that tax factors are unable to explain the price deviations as investors in a third party country do not have tax advantages. However, their argument is invalid if a marginal investor is not from the same third party country.

This chapter examines whether differences in taxation arrangements, including franking credit rates and personal dividend tax rates between the UK and Australia, play a significant role in explaining the price divergence of BHP and Billiton ADRs. Tax differences affect the net received dividend, and this might influence investors' valuation of the respective stocks. This chapter focuses on the premium between two ADRs, instead of two DLC twins because the ADRs are dominated in US dollars, and they trade in the same time-zone. The testable hypothesis is shown below:

Hypothesis 3.1: *The price premium between BHP and Billiton ADRs can be significantly explained by differences in taxation arrangements between Australia and the UK.*

3.4 Data collection

Dividend data and the ex-dividend date for BHP and Billiton are collected from the BHP Group website. Book value of equity, net income, and other accounting data are collected from annual reports. Further, this chapter also retrieves daily stock prices, the cost of equity for the BHP ADR and the Billiton ADR[6], the exchange rate and control variables [including the market index (FTSE 100, ASX 200, S&P 500), liquidity proxies (trading volume and the total number of shares outstanding for BHP ASX, Billiton LSE, BHP ADR NYSE, and Billiton ADR NYSE)] from Bloomberg. Historical tax rates, franking credits, GDP, CPI, export, import, current account, and the unemployment rate for both Australia and the UK are sourced from the respective government websites. Tick-by-tick

[6]There are two traditional formulas to estimate the cost of equity – the dividend capitalization model and the capital asset pricing model (CAPM). The cost of equity used in this thesis is provided by Bloomberg. Bloomberg uses the CAPM to calculate the cost of equity as shown below.

$$Cost\ of\ equity = R_f + \beta * (R_m - R_f) \tag{3.1}$$

where R_f is the risk-free rate measured as the rate of return paid on risk-free investments such as Treasuries. β is a measure of risk calculated by regressing the company's stock return on a relative index return using two years of historical weekly data. R_m is the required rate of return of the market. This method of calculation does not need to consider currency and capital structure changes, i.e., it is a levered equity beta.

bid and ask prices for calculating lagged daily time-weighted bid-ask spread are obtained from Thompson Reuters Tick History (TRTH). ADR ownership holdings of BHP and Billiton are collected from Thompson Reuters Ownership Data (S34) in Wharton Research Data Services (WRDS). This database contains the number of shares of BHP and Billiton traded on US markets as ADRs. The sample is from June 30, 2001 to June 30, 2018.

3.5 Methodology

This chapter extends Grossmann et al.'s (2007) method and applies multivariate OLS linear regression to test hypothesis 3.1. First, this chapter constructs a dependent variable to measure the actual price premium in Section 3.5.1. Second, this chapter constructs two independent variables to capture changes in tax differences between Australia and the UK - the effective tax rate difference dummies in Section 3.5.2 and estimated price premium in Section 3.5.3. This chapter then constructs the estimated price premium using the GGM in Section 3.5.4 and the RIM in Section 3.5.5. Next, this chapter discusses the control variables that could help explain the premium drawing on the previous literature and summarises the variables in Section 3.5.6. Finally, this chapter describes the model specification, which investigates the impact of the effective tax rate difference dummies and the estimated price premium on the magnitude of the actual price premium in Section 3.5.7.

3.5.1 Dependent variable

Similar to Grossmann et al. (2007), this chapter uses the daily price premium as the dependent variable to measure the magnitude of price deviations. The daily price premium (PR_t) is calculated by using daily closing BHP ADR price minus daily closing Billiton ADR price divided by their average as:

$$PR_t = \frac{BHP\,ADR_t - Billiton\,ADR_t}{(BHP\,ADR_t + Billiton\,ADR_t)/2}, \tag{3.2}$$

where $BHP\,ADR_t$ is the daily closing price for BHP ADR at time t, and $Billiton\,ADR_t$ is the daily closing price for Billiton ADR at time t.

3.5.2 Independent variable – the effective tax rate difference dummies

The first independent variable is the effective tax rate difference dummy variables that capture the changes in tax differences on distributed dividends to investors directly. The advantage of this measure is that it captures the absolute difference in the taxes on dividends, which incorporates both franking credit rate and the top marginal personal dividend tax rate. The formulas for calculating the effective tax rates in the UK and Australia and their differences are shown below:

$$Diff\_\tau_{e,t} = \tau_{e,t,UK} - \tau_{e,t,AUS}, \tag{3.3}$$

$$\tau_{e,t,UK} = 1 - \frac{(1-\tau_{p,t,UK})}{(1-F_{t,UK})}, \tag{3.4}$$

$$\tau_{e,t,AUS} = 1 - \frac{(1-\tau_{p,t,AUS} - \tau_{m,t,AUS})}{(1-F_{t,AUS})}, \tag{3.5}$$

where $Diff\_\tau_{e,t}$ is the effective tax rate difference between the UK and Australia at time t, $\tau_{e,t,UK}$ is the effective tax rate in the UK at time t, $\tau_{e,t,AUS}$ is the effective tax rate in Australia at time t, $\tau_{p,t,UK}$ is the top marginal personal dividend tax rate in the UK at time t, $F_{t,UK}$ is the franking credit rate in the UK at time t, $\tau_{p,t,AUS}$ is the top marginal personal dividend tax rate in Australia at time t, $F_{t,AUS}$ is the franking credit rate in Australia at time t, $\tau_{m,t,AUS}$ is the Medicare levy rate in Australia at time t.

From Table 3.2[7], BHP shareholders receive a net dividend of \$53 which is around 7% higher than the net dividend of \$49.52 obtained by Billiton shareholders. The effective tax rate in Australia $\tau_{e,t,AUS}$ that described in Eq. (3.5) is 1-(1-47%)/(1-30%) = 24.29%. The effective tax rate in the UK $\tau_{e,t,UK}$ that described in Eq. (3.4) is 1-(1-38.1%)/(1-10%) = 31.22%. The effective tax difference $Diff\_\tau_{e,t}$ described in Eq. (3.3) is calculated by using $\tau_{e,t,UK}$ minus $\tau_{e,t,AUS}$. Thus, the effective tax rate difference $Diff\_\tau_{e,t}$ is equal to 6.93% calculated by 31.22%-24.29%. This means that investors in the UK have to pay 6.93% more tax than Australian investors when receiving the same amount of dividend.

Table 3.3 shows the changes in the historical effective tax rate difference between the UK and Australia based on Eq. (3.3). There are five changes: 1) the effective tax rate difference increased from -1.43% to 1.43% caused by a decrease of 2% in the top marginal personal dividend tax rate in Australia on July 1, 2006; 2) the effective tax rate difference increased from 1.43% to 12.54% caused by an increase of 10% in the top marginal personal dividend tax rate in the UK on April 6, 2010; 3) the effective tax rate difference decreased from 12.54% to 6.99% caused by a decrease of 5% in the top marginal personal dividend tax rate in the UK on June 6, 2013; 4) the effective tax rate difference decreased from 6.99% to 6.27% caused by an increase of 0.5% in Medicare levy in Australia on July 1, 2014; 5) the effective tax rate difference increased from 6.27% to 6.93% caused by an increase of 0.6% the top marginal personal dividend tax rate in the UK on April 6, 2016. Annual tax rate changes effectively on April 06 in the UK and on July 01 in Australia.

Five dummy variables (i.e., effective tax rate difference dummies) constructed to cap-

[7] The tax rates in Australia in 2017-2018 are used in this table. Historical corporate tax rates and personal income tax rates are shown in Table B.1 in Appendix B.

[8] The calculation is described in Eq. (3.3) in Section 3.5.2.

Table 3.3: The effective tax rate difference and effective tax rate difference dummies between the UK and Australia

The table reports the effective tax rate difference and effective tax rate difference dummies between the UK and Australia from 2001 to 2018. The effective tax rate difference ($Diff\_\tau_{e,t}$) is calculated as the effective tax rate in the UK ($\tau_{e,UK}$) minus the effective tax rate in Australia ($\tau_{e,AUS}$)[8]. The effective tax rate difference dummy change date is the first ex-dividend date after the tax change date as discussed in Section 3.5.2. The ex-dividend dates are obtained from Table B.3 in Appendix B.

Date from	Date to	$\tau_{e,UK}$	$\tau_{e,AUS}$	$Diff\_\tau_{e,t}$	Dummy change date	Effective tax rate difference dummies
Jul 1, 2001	Jun 30, 2006	25%	26.43%	-1.43%		
Jul 1, 2006	Apr 5, 2010	25%	23.57%	1.43%	Sep 6, 2006	D_1
Apr 6, 2010	Apr 5, 2013	36.11%	23.57%	12.54%	Sep 8, 2010	D_2
Apr 6, 2013	Jun 30, 2014	30.56%	23.57%	6.99%	Sep 4, 2013	D_3
Jul 1, 2014	Apr 5, 2016	30.56%	24.29%	6.27%	Sep 3, 2014	D_4
Apr 6, 2016	Apr 5, 2018	31.22%	24.29%	6.93%	Aug 31, 2016	D_5

ture the changes in effective tax difference between the UK and Australia are also shown in Table 3.3. Which date should be used for the effective tax dummy change date? In this chapter, the effective tax rate difference dummy change date shown in Table 3.3 is the first ex-dividend date after the effective tax rate change date as this ex-dividend date is the date when investors' welfare is first impacted by the tax rate change.

D_1, D_2 and D_5 indicate a widening of the tax rate difference. The coefficient on these three variables is expected to be positive and significant, revealing that tax rate differentials help explain the mispricing because in all cases the tax advantage of the Australian system increased relative to the UK. D_3 and D_4 proxy for decreases in the tax advantage of Australia relative to the UK. Hence, the coefficient on these two dummies is expected to be negative and significant to support our tax-based explanation.

$$D_1 = \begin{cases} 1, & \text{if date is after September 6, 2006 when the first dividend goes ex-dividend} \\ & \text{after the effective tax rate difference increases from -1.43\% to 1.43\%} \\ 0, & \text{otherwise} \end{cases} \tag{3.6}$$

$$D_2 = \begin{cases} 1, & \text{if date is after September 8, 2010 when the first dividend goes ex-dividend} \\ & \text{after the effective tax rate difference increases from 1.43\% to 12.54\%} \\ 0, & \text{otherwise} \end{cases} \tag{3.7}$$

$$D_3 = \begin{cases} 1, & \text{if date is after September 4, 2013 when the first dividend goes ex-dividend} \\ & \text{after the effective tax rate difference decreases from 12.54\% to 6.99\%} \\ 0, & \text{otherwise} \end{cases} \tag{3.8}$$

$$D_4 = \begin{cases} 1, & \text{if date is after September 3, 2014 when the first dividend goes ex-dividend} \\ & \text{after the effective tax rate difference decreases from 6.99\% to 6.27\%} \\ 0, & \text{otherwise} \end{cases} \tag{3.9}$$

$$D_5 = \begin{cases} 1, & \text{if date is after August 31, 2016 when the first dividend goes ex-dividend} \\ & \text{after the effective tax rate difference increases from 6.27\% to 6.93\%} \\ 0, & \text{otherwise} \end{cases} \tag{3.10}$$

Before presenting formal regression results, this section depicts visual evidence of the association between the ADR premium and the tax rate differential during our sample period in Fig. 3.5. The volatile line represents the price premium. The stepped line shows the tax difference for the UK relative to Australia. It seems that the share price is anticipating the tax regime changes. A strong co-movement between the price premium and tax difference is evident, suggesting that tax rate differences might explain the price premium between these two ADRs.

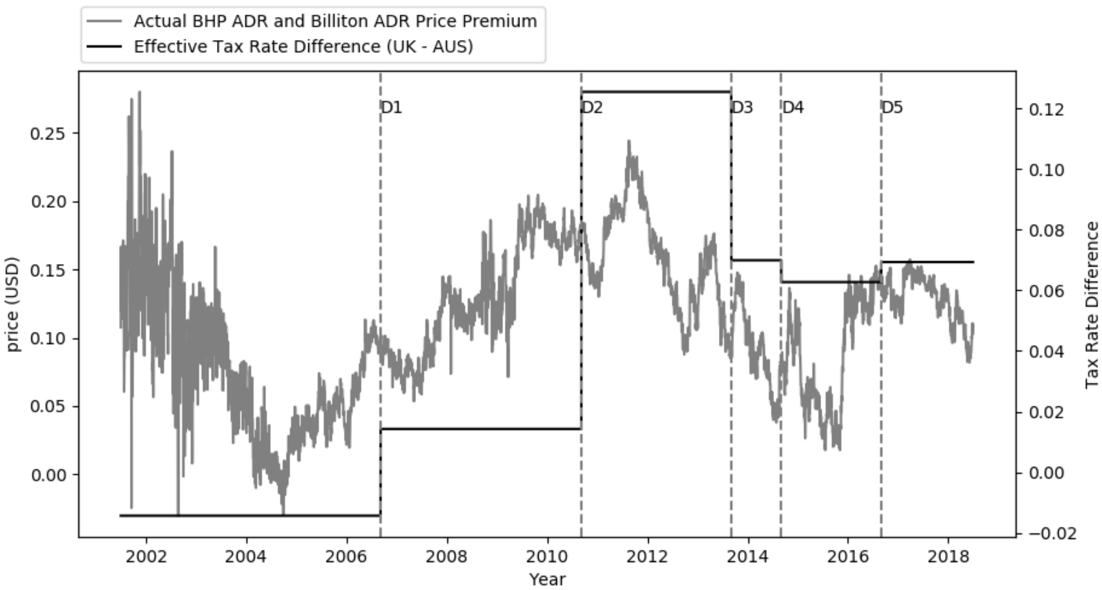

Fig. 3.5. This figure plots the actual price premium between BHP ADR and Billiton ADR and the effective tax rate difference of the UK over Australia for daily observations in the period from June 30, 2001 to June 30, 2018. Share price data are collected from Bloomberg.

3.5.3 Independent variable – estimated price premium

This chapter estimates the price premium as the difference in estimated prices between the BHP twins based on the net dividends, cost of equity, and growth rate using two popular valuation models. The Estimated Price Premium $E[PR_t]$ is calculated as

$$E[PR_t] = \frac{E[BHP\,ADR_t] - E[Billiton\,ADR_t]}{(E[BHP\,ADR_t] + E[Billiton\,ADR_t])/2}, \tag{3.11}$$

where $E[BHP\ ADR_t]$ is the daily estimated valuation of the BHP ADR at time t, and $E[Billiton\,ADR_t]$ is the daily estimated valuation of the Billiton ADR at time t. $E[BHP\,ADR_t]$ and $E[Billiton\,ADR_t]$ are calculated using the GGM and the RIM as the sum of the present value of future net dividend streams of both ADRs, as described below.

3.5.4 Gordon growth model

The GGM is a two-stage Dividend Discount Model (DDM) derived by Gordon and Shapiro (1956). The DDM is one of the fundamental approaches to value a firm's equity value. A basic assumption of this model is that the value of a stock is equal to the present value of all its future dividend payments, discounted by the firm's cost of equity. The GGM is a special case of the DDM when the dividend growth rate and cost of equity are constant during a terminal estimation period.

This chapter applies a two-step GGM approach to calculating the estimated share prices and extends it by incorporating franking credits and personal dividend tax. First, this chapter calculates the net dividends for both the BHP ADR and the Billiton ADR as distributed dividends after the effective tax rate (franking credits, and personal dividend tax rates) as:

$$DIV_{BHP\ ADR_t} = DIV_t * (1 - \tau_{e,t,AUS}), \tag{3.12}$$

$$DIV_{Billiton\ ADR_t} = DIV_t * (1 - \tau_{e,t,UK}), \tag{3.13}$$

where DIV_t is the distributed dividend of both BHP ADR and Billiton ADR at time t, $DIV_{BHP\ ADR_t}$ is the net dividend of BHP ADR at time t, $DIV_{Billiton\ ADR_t}$ is the net dividend of Billiton ADR at time t.

Second, this chapter estimates the daily share prices using the two-stage GGM with net dividends and discount rates for both BHP ADR and Billiton ADR. This calculation is based on the assumption that investors predict the cash amount of all distributed dividends during the first state[9]. Assuming the share price is estimated at time t, the first stage is defined as the period between the time t and the time when the 6th dividend after time t is distributed. The model also assumes that investors can predict the 7th dividend after time t and uses this dividend to calculate the terminal value for the second stage. The second stage stands for the infinite period starting after the distribution of the 7th dividend. The growth rate is the geometric average of the return of dividends during the sample period. The two-stage GGM is shown as:

$$E[BHP\ ADR_t] = \sum_{n=1}^{6} \frac{DIV_{BHP\ ADR_{t+n}}}{(1+r)^n} + \frac{DIV_{BHP\ ADR_{t+7}}}{(r-g)(1+r)^6}, \tag{3.14}$$

$$E[Billiton\ ADR_t] = \sum_{n=1}^{6} \frac{DIV_{Billiton\ ADR_{t+n}}}{(1+r)^n} + \frac{DIV_{Billiton\ ADR_{t+7}}}{(r-g)(1+r)^6}, \tag{3.15}$$

where $E[BHP\ ADR_t]$ is the estimated BHP ADR price at time t, $E[Billiton\ ADR_t]$ is the estimated Billiton ADR price at time t, g is the assumed growth rate for the second stage. The estimated prices of BHP and Billiton ADRs and half of the actual prices of BHP and Billiton ADRs are shown in Fig. 3.6 and Fig. 3.7.

[9] It might be argued that investors cannot predict the exact amount of dividend prior to the announcement date. Accordingly, a robustness test is examined that replaces historical dividends with estimated dividends from a simple AR model based on previous dividends. Specific descriptions of the calculation of estimated dividends are shown in Appendix D. The results of this robustness test are shown in Panel A in Table 3.7. Similar conclusions are drawn using this alternative approach compared to those reported in this chapter.

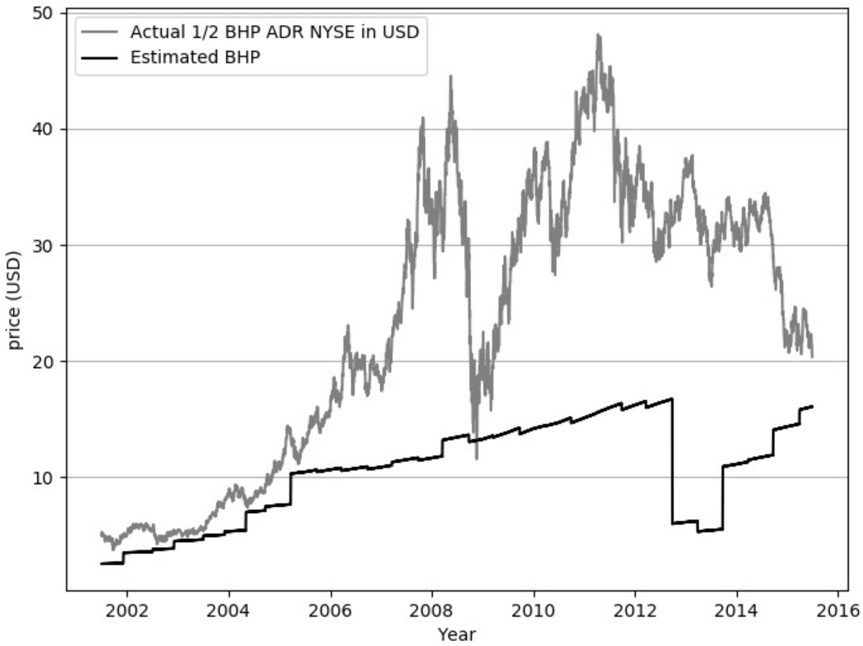

Fig. 3.6. The figure plots the prices of half of the estimated BHP ADR or half of actual BHP ADR in the period from June 30, 2001 to June 30, 2015. Share price data are collected from Bloomberg.

Fig. 3.7. The figure plots the prices of half of the estimated Billiton ADR or half of actual Billiton ADR in the period from June 30, 2001 to June 30, 2015. Share price data are collected from Bloomberg.

The GGM is a valuation model for estimating the intrinsic value of a stock based on a series of future dividends growing at a constant rate. Farrell (1985) suggests that the GGM better fits a company that pays a stable portion of its net income as a dividend. It is also more suitable for a mature firm with a lower growth rate relative to the cost of equity. BHP Group meets these two requirements during our sample period[10]. Given that the discount rates of BHP ADR and Billiton ADR are similar or equal and the growth rates of dividends of BHP ADR and Billiton ADR are identical, the deviation of estimated prices between the ADR twins should only be determined by tax differences in net dividends.

3.5.5 Residual income model

The RIM proposed by Ohlson (2001) is an alternative technique to estimate the value of equity. The RIM is similar to the DDM in its basic structure. Compared with the DDM, it substitutes future residual earnings for dividend payments. The DDM provides an advantage that it is more suitable for firms that do not pay dividends or have unpredictable dividend flows. In addition, the RIM pays more attention to a firm's economic profitability instead of its accounting profitability. Almost all researchers reach the same conclusion that the RIM and the DDM are equivalent in theory. However, Courteau, Kao, and Richardson (2001), Francis, Olsson, and Oswald (2000), and Penman and Sougiannis (1998) suggest that the RIM is superior to the DDM and show that they yield different estimates. However, Lundholm and O'Keefe (2001) argue that the RIM and the DDM are still equivalent empirically. The original RIM states that a firm's equity value is the sum of its book value and the present value of all its expected future residual income. In personal finance, residual income means excess cash or disposable income. However, residual income is defined as the earnings for that period less for the cost of equity. The charge is the product of equity capital at the year beginning and cost of equity. The derivation of the RIM is shown below as:

$$P_t = b_t + \sum_{\tau=1}^{\infty} \frac{E_t[X_{t+\tau}{}^a]}{(1+r)^\tau}, \tag{3.16}$$

$$X_{t+\tau}{}^a = X_{t+\tau} - r * b_{t+\tau-1}, \tag{3.17}$$

where $X_{t+\tau}{}^a$ is residual income, $X_{t+\tau}$ is the net income during a year ending $t+\tau$, r is the cost of equity, and $b_{t+\tau-1}$ is the book value of equity at the beginning of a year $t+\tau$.

However, this chapter does not use the above formula directly. In Appendix C.1, this chapter starts with the DDM and derives Eq. (3.16) and Eq. (3.17). These equations are

[10]BHP Group has recently suffered substantial losses associated with reduced commodity prices and a tailings dam collapse that caused iron ore production at its jointly owned (with Vale Corporation) operations in Brazil to be suspended. The dam collapse resulted in a substantial loss of human life. BHP's dividends were dramatically reduced following this disaster.

the restatement of the DDM when the clean surplus relation is valid. This chapter then incorporates tax factors, including the franking credit rate and personal tax rates, into the derivation and finds that the original RIM cannot be derived because personal tax rates are not constant each year. Finally, this chapter returns to the underlying starting setting that share price is the present value of expected future net dividends discounted at the cost of equity capital and consider tax factors, thus getting an amended version of RIM in Eq. (3.18) below as:

$$P_t = \sum_{\tau=1}^{\infty} \frac{E[b_{t+\tau-1} + X_{t+\tau} - b_{t+\tau}](1 - T_{d,t+\tau})}{(1 - F_{t+\tau})(1+r)^{\tau}}. \tag{3.18}$$

If the clean surplus relation perfectly holds in the accounting statements, our amended version of the RIM is the same as the DDM shown below:

$$P_t = \sum_{\tau=1}^{\infty} \frac{E[d_t](1 - T_{t+\tau})}{(1 - F_{t+\tau})(1+r)^{\tau}}. \tag{3.19}$$

Hence, our valuation estimates would be indifferent to the DDM. However, the analysis shows that the clean surplus relation does not hold perfectly in the BHP Group case[11].

Irrespective of whether our model uses the GGM or the RIM, the independent variable (the estimated price premium) is determined by net dividends, the franking credit rates, the top marginal personal dividend tax rates, and the discount rates. In both these approaches, since net dividends are identical for BHP ADR and Billiton ADR, only the franking credit rates, the top marginal personal dividend tax rates, and the discount rates cause differences in the valuations. Therefore, the estimated price premium captures the tax differences between Australia and the UK on a daily basis.

3.5.6 Control variables

This chapter adds control variables that could explain the premium according to the previous literature (Pontiff, 1996; Copeland and Copeland, 1998; Froot and Dabora, 1999; Bedi et al., 2003; Keele and Kelly, 2006; Grossmann et al., 2007; De Jong et al., 2009; Su et al., 2013). These variables are lagged log return premium of BHP over Billiton to control for autocorrelation; the daily log index return and exchange rate to control for market return; bid-ask spread to control for transaction costs; lagged turnover ratio to control for liquidity; GDP, CPI, imports, exports, current assets and the unemployment rate to control for macroeconomic indicators. All dependent variables, independent variables and control variables are described in Table F.1 in Appendix F.

The OLS regression model normally assumes that there is no autocorrelation between

[11] The evidence of the violations of the clean surplus relation is shown in Appendix C.2, which shows that except in the years where the group has a major merger or demerger (2003 and 2015), the sum of the clean surplus violations is generally less than one percent of shareholders' equity.

time series residuals. Lagged log return premium is included to control the autocorrelation (Keele and Kelly, 2006). Daily log index returns of ASX200, FTSE100, and S&P500 are included in the model to control for market return as Froot and Dabora (1999) show that the price difference between twin securities are correlated with the markets where they are traded. Their findings are bolstered by Bedi et al. (2003), Grossmann et al. (2007), De Jong et al. (2009), and Su et al. (2013). Even though both BHP ADRs and Billiton ADRs are traded in the US, their underlying are traded in Australia and the UK. It is thus reasonable to include the index returns in Australia and the UK in the model. Compared with Grossmann et al. (2007) and other literature that investigates the price differential between DLC twins, the exchange rate difference problem has been addressed by shifting our focus to ADR twins. However, the log return of the exchange rate is still included as Copeland and Copeland (1998) find the exchange rate positively impacts the market return and thus contributes to the price premium. Transaction cost controls are also added due to the findings of Grossmann et al. (2007) who claim that mispricing is more severe when transaction costs are higher and Pontiff (1996) who argues that transaction costs reduce security mispricing and impede potential arbitrage opportunities. This chapter follows and extends Grossmann et al.'s (2007) methodology and uses the bid-ask spread[12] as the proxy for transaction costs. Lagged turnover ratio is included to measure liquidity (Hu, 1997). Lagged turnover ratio is a better variable than trading volume to measure liquidity as it captures capital structure changes, including splits, share dividends, and share issues. Important economic indicators for Australia and the UK, such as GDP, CPI, national current account, imports, exports, and the unemployment rate are controlled in the model (Su et al., 2013). If the tax explanation holds, the ADR ownership holdings of BHP and Billiton will affect the mispricing as Australian and the UK investors are eligible for franking credits while US investors are not[13]. $ADR\ diff$ is added in the regression in the robustness test as a proxy for the difference in ADR ownership holdings between BHP and Billiton. $ADR\ diff$ is calculated as the relative difference in the percentage of ADR ownership between BHP and Billiton shown as below:

$$ADR\ diff_t = \frac{(BHP\ ADR\ ownership\ perc_t - Billiton\ ADR\ ownership\ perc_t)}{(BHP\ ADR\ ownership\ perc_t + Billiton\ ADR\ ownership\ perc_t)/2}, \tag{3.20}$$

where $BHP\ ADR\ ownership\ perc_t$ is the percentage of ADR ownership holdings of BHP, $Billiton\ ADR\ ownership\ perc_t$ is the percentage of ADR ownership holdings of Billiton. This variable is expected to be negatively related with the mispricing. The increase of the $ADR\ diff$ could be caused by either the increase of the percentage of BHP ADR ownership or the decrease of the percentage of Billiton ADR ownership. If the percentage

[12]This chapter first adopts McInish and Wood's (1992) method to calculate quoted spread for each instrument and then calculated a weighted average of quoted spread weighting by eigenvector (Kalivas, 1999) as quoted spreads for four instruments are highly correlated with each other.

[13]We thank Keith Godfrey for this suggestion.

of BHP ADR ownership increases, BHP share prices will decrease as US investors place a lower valuation of BHP than Australian investors for tax reasons[14]. If the percentage of Billiton ADR ownership decreases, Billiton share prices will increase as UK investors place a higher valuation of Billiton than US investors. Both these two cases contribute to increased mispricing.

3.5.7 Model specification

Hypothesis 3.1 states that price differences between BHP and Billiton ADRs can be significantly explained by differences in tax factors between Australia and the UK. To measure the relationship between the actual price differences and tax differences, this chapter constructs three time-series OLS linear regressions by regressing the actual price differences on five dummy variables that capture the differences in effective tax rates between the UK and Australia discussed in Section 3.5.2, and differences in estimated prices using the GGM and the RIM respectively discussed in Section 3.5.3. These three equations are shown below as:

$$PR_t = \beta_0 + d_1 * D_1 + d_2 * D_2 + d_3 * D_3 + d_4 * D_4 + d_5 * D_5 + \sum_{i=1}^{23} B_i * X_i + \varepsilon_t, \qquad (3.21)$$

$$PR_t = \beta_0 + \beta_1 * E[PR_{GGM,t}] + \sum_{i=1}^{23} B_i * X_i + \varepsilon_t, \qquad (3.22)$$

$$PR_t = \beta_0 + \beta_1 * E[PR_{RIM,t}] + \sum_{i=1}^{23} B_i * X_i + \varepsilon_t. \qquad (3.23)$$

Hypothesis 3.1, developed from an inspection of the tax rate changes in Fig. 3.5, is that the price premium should be significantly correlated with the tax dummies, i.e., d_1, d_2, and d_5 should be positive while d_3 and d_4 should be negative from Eq. (3.21). Also, hypothesis 3.1 expects β_1 in Eq. (3.22) and Eq. (3.23) to be positive.

3.6 Empirical results

This section presents the analysis across all relevant determinants. Further, it shows the regression coefficients on tax explanatory variables, including the effective tax difference dummy variables, estimated price premium using the GGM, and the RIM. Finally, this section verifies the robustness of our findings by assuming that tax changes take effect on various dates, and investors have the ability to obtain the tax change and dividend

[14]The evidence shows that "BHP (Billiton) and their respective ADRs trade at the same price" and the argument that "US investors place a lower valuation of BHP than Australian investors for tax reasons" are not contradictory because BHP (Billiton) and their ADRs are exchangeable. It is assumed that the marginal investors of BHP are Australian investors - BHP sets the price, and BHP ADR follows that price.

information in advance, estimating the GGM with estimated dividends derived from AR model, and utilising monthly estimated GGM.

3.6.1 Summary statistics

Table 3.4 provides the summary statistics including the mean, median, standard deviation, minimum and maximum value of each variable used in Eq. (3.22) and Eq. (3.23). This allows the magnitudes and dispersions of the variables to be examined. The dependent variable (PR_t) in Panel A has a positive mean and median (0.1113 and 0.1158 respectively), indicating that BHP ADR is priced higher than Billiton ADR on average during our sample period. The estimated price premiums in Panel B based on the GGM and the RIM present similar mean and median values, which are more than twice as high as those for the actual price premium in Panel A. The standard deviation of estimated price premium using the GGM and RIM is close to that of actual price premium, which indicates the reliability of the estimating models. In addition, Panel C shows that all control variables except weighted quoted spread have values close to zero for both the mean and median.

Table 3.4: Summary Statistics

This table reports summary statistics for variables used in Eq. (3.22) and Eq. (3.23) from June 30, 2001 to June 30, 2018. The definitions of the variables are provided in Table F.1 in Appendix F.

Variable			Mean	Median	Std.	Min.	Max.
Panel A: Dependent Variable							
Price Premium		PR_t	0.1113	0.1158	0.0515	-0.0303	0.2801
Panel B: Dependent Variable							
Estimated	GGM	$E[PR_{GGM,t}]$	0.2097	0.1950	0.0558	0.1249	0.3064
Price Premium	RIM	$E[PR_{RIM,t}]$	0.2223	0.2050	0.0617	0.1368	0.3422
Panel C: Control Variables							
Lagged Log Return Premium		$LLRPR_t$	0.0000	0.0000	0.0121	-0.1276	0.3011
Index	Australia	r_{ASX200_t}	0.0001	0.0000	0.0082	-0.0871	0.0563
Log Return	UK	$r_{FTSE100_t}$	0.0000	0.0000	0.0097	-0.0927	0.0938
	US	$r_{S\&P500_t}$	0.0001	0.0000	0.0098	-0.0947	0.1096
Exchange Rate	AUD	r_{AUD_t}	0.0001	0.0000	0.0068	-0.0805	0.0658
Log Return	GBX	r_{GBX_t}	0.0000	0.0000	0.0050	-0.0814	0.0444
Weighted Quoted Spread		WSP_t	8.3908	5.0558	7.4838	2.3399	58.8219
Lagged	BHP ASX	$LTR_{BHP\ ASX,t}$	0.0041	0.0036	0.0023	0.0004	0.0276
Turnover Ratio	Billiton LSE	$LTR_{Billiton\ LSE,t}$	0.0016	0.0014	0.0012	0.0000	0.0115
	BHP ADR	$LTR_{BHP\ ADR,t}$	0.0057	0.0047	0.0038	0.0000	0.0595
	Billiton ADR	$LTR_{Billiton\ ADR,t}$	0.0008	0.0006	0.0009	0.0000	0.0092
GDP	Australia	r_{GDP,AU_t}	0.0002	0.0000	0.0018	-0.0123	0.0368
Log Return	UK	r_{GDP,UK_t}	0.0001	0.0000	0.0013	-0.0161	0.0254
CPI	Australia	r_{CPI,AU_t}	0.0001	0.0000	0.0008	-0.0032	0.0164
Log Return	UK	r_{CPI,UK_t}	0.0000	0.0000	0.0266	-0.6931	0.6931
Imports	Australia	$r_{imports,AU_t}$	0.0000	0.0000	0.0066	-0.1521	0.1051
Log Return	UK	$r_{imports,UK_t}$	0.0001	0.0000	0.0034	-0.1184	0.1084
Exports	Australia	$r_{exports,AU_t}$	0.0002	0.0000	0.0047	-0.0714	0.0977
Log Return	UK	$r_{exports,UK_t}$	0.0001	0.0000	0.0038	-0.1242	0.1165
Current	Australia	r_{CA,AU_t}	0.0002	0.0000	0.0273	-0.8307	1.0176
Account Log Return	UK	r_{CA,UK_t}	0.0002	0.0000	0.0431	-0.8973	1.4195
Unemployment	Australia	r_{UR,AU_t}	-0.0001	0.0000	0.0049	-0.0597	0.0785
Rate Log Return	UK	r_{UR,UK_t}	0.0000	0.0000	0.0039	-0.0764	0.1038

3.6.2 Regression results

Table 3.5 reports the OLS regression results of Eq. (3.21), Eq. (3.22), and Eq. (3.23). Panel A in Table 3.5 shows that the coefficients on D_1, D_2, and D_5 are 0.062, 0.0162, and 0.0456 with t-statistics of 24.467, 8.25, and 22.801 respectively; all are significant at 1% level. D_1, D_2 and D_5 represent the effective tax rate difference of the UK over Australia growing from -1.43% to 1.43%, from 1.43% to 12.54%, and from 6.27% to 6.93% respectively. The coefficients of these dummy variables are interpreted as the influence of changes in the effective tax rate difference of the UK over Australia on the magnitude of BHP mispricing. Positive signs on these three dummy variables are consistent with the mispricing being more severe when the gap in the tax rate between Australia and the UK increases. In addition, the coefficients on D_3 and D_4 are -0.0508 and -0.0304 with t-statistics of -20.888 and -10.539 (both significant at 1% level). D_3 and D_4 represent the effective tax rate difference dropping from 12.54% to 6.99%, and from 6.99% to 6.27%. Negative signs on the third and fourth dummy variables indicate that the price divergences become narrower when the tax rate gap decreases. The results are consistent with hypothesis 3.1 that tax rate changes can explain the actual price premium, and the price of BHP is higher than that of Billiton because of the higher effective tax rate in the UK than in Australia (higher franking credits in Australia than that in the UK). The F-statistic is 210.4, and it is significant at 1% level. Panel B indicates that the coefficient on the estimated price premium using the GGM is 0.4146 with a t-statistic of 23.525 (significant at 1%). This means that one percent growth in the estimated price premium leads to a 0.41 percent growth in actual price premium. As discussed in Section 3.5.4, the estimated price premium using the GGM is a daily proxy for tax differences by calculating the sum of the present value of net dividend flows that are distributed dividends with attached franking credits after subtracting personal dividend taxes. Hence we can argue that tax differences are responsible for the change in the actual price premium. Panel C presents the regression results from the RIM model. The RIM differs from the GGM by substituting future residual earnings for dividend payments, which fits more for firms paying unstable dividends, as discussed in Section 3.5.5. Panel C reports that the estimated coefficient on the main independent variable, the estimated price premium, is 0.1633 with a t-statistic of 11.1 (significant at 1%). The coefficient indicates that a one percent increase in estimated price premium using the RIM contributes to a 0.16 percent increase in actual price premium, which is consistent with statistics from the GGM-based estimation.

Table 3.5: OLS Model Estimates

This table reports the estimates of coefficients from OLS Regression models

$$PR_t = \beta_0 + d_1 * D_1 + d_2 * D_2 + d_3 * D_3 + d_4 * D_4 + d_5 * D_5 + \sum_{i=1}^{23} B_i * X_i + \varepsilon_t, \tag{3.20}$$

$$PR_t = \beta_0 + \beta_1 * E[PR_{GGM,t}] + \sum_{i=1}^{23} B_i * X_i + \varepsilon_t, \tag{3.21}$$

$$PR_t = \beta_0 + \beta_1 * E[PR_{RIM,t}] + \sum_{i=1}^{23} B_i * X_i + \varepsilon_t, \tag{3.22}$$

where the independent variables are effective tax difference dummy variables D_{1-5} and the estimated price premium $E[PR_t]$ using the GGM and the RIM in Panel A, B, and C, respectively. The dependent variable PR_t is the daily price premium calculated by the daily ratio of BHP ADR price minus daily Billiton ADR price over their average. In Panel A, the independent variables are five effective tax difference dummy variables D_{1-5} equaling to one after the first BHP ex-dividend date that follows an effective tax difference change. In Panel B, the independent variable $E[PR_t]$ is the estimated price premium of BHP over Billiton ADRs estimated by the GGM. In Panel C, the independent variable $E[PR_t]$ is the estimated price premium of BHP over Billiton ADRs estimated by the RIM. X_i stand for 23 control variables described below in Table F.1. The regression uses heteroskedasticity-consistent standard error estimator (Davidson and MacKinnon, 1993) and significance at the 10%, 5% and 1% levels is indicated by *, ** and ***, respectively. T-statistics are reported in parentheses. The sample period is from June 30, 2001 to June 30, 2018.

Panel	Panel A	Panel B	Panel C
Model	Eq. (3.21)	Eq. (3.22)	Eq. (3.23)
Intercept	0.0556***	0.0175***	0.051***
	(17.292)	(4.263)	(11.915)
D_1	0.062***		
	(24.467)		
D_2	0.0162***		
	(8.25)		
D_3	-0.0508***		
	(-20.888)		
D_4	-0.0304***		
	(-10.539)		
D_5	0.0456***		
	(22.801)		
$E[PR_t]$		0.4164***	0.1633***
		(23.525)	(11.1)
$LLRPR_t$	0.2582***	0.2972***	0.2793**
	(3.149)	(2.921)	(2.554)
r_{ASX200_t}	0.044	0.0254	0.046
	(0.778)	(0.34)	(0.561)
$r_{FTSE100_t}$	-0.0795	-0.1198	-0.1602
	(-1.314)	(-1.548)	(-1.795)
$r_{S\&P500_t}$	0.0247	0.0588	0.0534

	(0.447)	(0.823)	(0.678)
r_{AUD_t}	0.1649**	0.1269	0.2495**
	(2.121)	(1.271)	(2.167)
r_{GBX_t}	-0.2751***	-0.1546	-0.318**
	(-2.842)	(-1.308)	(-2.054)
WSP_t	0.0002	-0.0009***	-0.0008***
	(1.594)	(-6.592)	(-5.809)
$LTR_{BHP\ ASX,t}$	0.1648	0.9495**	1.4727***
	(0.5)	(2.39)	(3.699)
$LTR_{BHP\ ADR,t}$	6.9019***	8.4852***	10.8788***
	(6.877)	(7.752)	(8.448)
$LTR_{Billiton\ LSE,t}$	-2.9332***	-4.0593***	-3.2705***
	(-10.421)	(-11.724)	(-9.703)
$LTR_{Billiton\ ADR,t}$	17.3152***	11.3128***	26.0712***
	(12.329)	(10.519)	(12.638)
r_{GDP,AU_t}	-0.519	0.0957	-0.003
	(-1.111)	(0.163)	(-0.005)
r_{GDP,UK_t}	0.5855	1.9347	0.6882
	(0.435)	(1.224)	(0.473)
r_{CPI,AU_t}	2.581**	0.6846	0.7317
	(2.225)	(0.449)	(0.457)
r_{CPI,UK_t}	-0.0005	0.0048	0.0232
	(-0.015)	(0.079)	(0.351)
$r_{imports,AU_t}$	-0.0103	-0.0345	-0.0584
	(-0.095)	(-0.256)	(-0.393)
$r_{imports,UK_t}$	-0.0831	-0.0151	1.2013
	(-0.118)	(-0.012)	(1.063)
$r_{exports,AU_t}$	-0.152	-0.0693	-0.1608
	(-1.007)	(-0.426)	(-0.77)
$r_{exports,UK_t}$	0.0674	-0.5095	-1.1887
	(0.09)	(-0.496)	(-1.096)
r_{CA,AU_t}	-0.0006	-0.0056	0.0017
	(-0.04)	(-0.249)	(0.056)
r_{CA,UK_t}	0.0017	-0.0002	-0.0139
	(0.099)	(-0.006)	(-0.506)
r_{UR,AU_t}	-0.0416	0.0466	-0.1446
	(-0.308)	(0.216)	(-0.642)
r_{UR,UK_t}	0.2875	0.6972	0.99**
	(0.875)	(1.681)	(2.375)
Observations	3284	3284	2650
Adjusted R-squared	69%	49.8%	53.1%
F-statistic	210.4	130.1	109.5

According to all panels in Table 3.5, the positive and significant coefficient on lagged log return premium indicates that autocorrelation exists in the dependent variable (Keele and Kelly, 2006). The coefficient on ASX Index log return is positive and the coefficient on LSE Index return is negative, which is consistent with Froot and Dabora (1999), Bedi et al. (2003), Grossmann et al. (2007), De Jong et al. (2009) and Su et al.'s (2013) findings that share prices are influenced by the market return for the home country. The coefficient on the log return of AUD is positive, and GBX is negative. The result confirms Copeland and Copeland's (1998) argument that the exchange rate is positively related to the market return. The coefficient on the weighted spread in Panel B is negative and significant at 1%. This finding is consistent with Pontiff's (1996) argument that transaction costs reduce mispricing but inconsistent with Grossmann et al.'s (2007) argument that transaction costs are positively correlated with the mispricing. The coefficient on the lagged turnover ratio is positive for BHP ASX and negative for Billiton LSE. Moreover, the mispricing is positively correlated with the turnover ratios for both BHP ADR and Billiton ADR. The coefficients on all economic indicators are insignificant and are unable to explain the price premium, thus confirming the conclusion of previous literature (Froot and Dabora, 1999; Bedi et al., 2003; De Jong et al., 2009; Su et al., 2013).

Overall, the analysis finds that the tax difference is a significant determinant of the change in the actual price premium no matter whether we apply dummy variables that capture the tax difference directly or implement daily valuation models, including the GGM and the RIM based on dividends and the cost of equity. This confirms the tax explanation hypothesis 3.1 but contradicts Froot and Dabora (1999) and Bedi et al.'s (2003) suggestion that tax cannot explain the price premium between DLC twins, albeit they do not formally test this proposition. Coefficients on most microstructure control variables are significant, and most macro-economic variables are insignificant.

3.6.3 Robustness tests

This section provides the results of robustness tests. In the initial effective tax difference model shown in Panel A in Table 3.5, the date on which the effective tax difference dummies change is the first ex-dividend date after the tax rate change date. Table 3.6 replaces the ex-dividend date with a date three months prior to the ex-dividend date, the tax change date, three months prior to the tax change date, the dividend announcement date, and the dividend payment date from Panel A to Panel E respectively. According to all Panels in Table 3.6, the relationship between the price premium and effective tax difference dummies still holds. Coefficients on other control variables are not shown in Table 3.6 as they are essentially the same as Panel A in Table 3.5.

Table 3.6: Robustness tests of dummy variable model

This table reports the robustness result of multivariate OLS Regression in which independent variables are effective tax difference dummy variables. The dependent variable PR_t is the daily price premium calculated by the daily ratio of BHP ADR price minus daily Billiton ADR price over their average. The independent variables D_{1-5} are five dummy variables equaling to one that captures the effective tax difference change. Five independent variables that proxy for effective tax difference dummy variables are used. In Panel A, the dummy changes three months before the ex-dividend date. In Panel B, the dummy changes on the tax change date. In Panel C, the dummy changes three months before the tax change date. In Panel D, the dummy changes on the dividend announcement date. In Panel E, the dummy changes on the dividend payment date. X_i stands for 23 control variables are the same as those in Table 3.5 and not shown in this table. The regression uses heteroskedasticity-consistent standard error estimator (Davidson and MacKinnon, 1993) and significance at the 10%, 5% and 1% levels is indicated by *, ** and ***, respectively. T-statistics are reported in parentheses. The sample period is from June 30, 2001 to June 30, 2018.

$$PR_t = \beta_0 + d_1 * D_1 + d_2 * D_2 + d_3 * D_3 + d_4 * D_4 + d_5 * D_5 + \sum_{i=1}^{23} B_i * X_i + \varepsilon_t, \tag{3.20}$$

	Panel A	Panel B	Panel C	Panel D	Panel E
Dummy change date	Three months before the ex-dividend date	Tax rate change date	Three months before the tax rate change date	Dividend announcement date	Dividend payment date
Intercept	0.0446***	0.0471***	0.0386***	0.0538***	0.0583***
	(14.789)	(14.954)	(12.803)	(16.818)	(17.958)
D_1	0.073***	0.0705***	0.08***	0.0632***	0.0601***
	(30.909)	(28.882)	(36.727)	(25.121)	(23.724)
D_2	0.0225***	0.023***	0.028***	0.0174***	0.0138***
	(10.658)	(9.933)	(11.051)	(8.856)	(7.141)
D_3	-0.045***	-0.0412***	-0.0304***	-0.0511***	-0.0515***
	(-23.387)	(-18.771)	(-13.611)	(-21.293)	(-21.315)
D_4	-0.0446***	-0.0486***	-0.0625***	-0.0317***	-0.029***
	(-20.672)	(-20.21)	(-27.517)	(-11.251)	(-10.092)
D_5	0.0498***	0.0505***	0.0527***	0.0471***	0.046***
	(28.055)	(26.662)	(28.285)	(24.263)	(22.347)
Observations	3284	3284	3284	3284	3284
Adjusted R-squared	73.9%	72.0%	74.3%	69.8%	68.1%
F-statistic	279.2	259.5	320.5	220.3	205.0

This chapter also tests the robustness of the the GGM model by adopting a model that predicts future dividends using a simple AR model[15] (rather than using actual dividends in the Panel B in Table 3.5) in Panel A in Table 3.7 and applying monthly observations (as opposed to daily observations in Panel B in Table 3.5) in Panel B in Table 3.7. Panel A in Table 3.7 illustrates that the coefficient on the estimated price premium using estimated dividends by the AR model is 0.74, with a t-statistic of 55.016 (significant at 1%). This indicates that one percent increase in the estimated premium using the GGM contributes to a 0.74 percent increase in the actual premium. This coefficient is even larger than the coefficient of 0.41 in Panel B in Table 3.5, and hence the use of actual dividends versus estimating future dividends does not change the conclusion. Results in Table 3.5 are therefore not caused by allowing perfect foresight of the actual dividends. Again our results support the proposition that tax differences are significant factors in explaining changes in the actual price premium, even when the assumption that investors cannot get the information about the exact amount of dividends is relaxed. Estimating our model with monthly observations (rather than daily observations in Panel B in Table 3.5) does not change the outcome materially. Panel B in Table 3.7 shows that the estimated coefficient on the estimated price premium is 0.18, with a t-statistic of 1.86 (significant at 10%). Although the explanatory power of the estimated premium is lower than daily observations, it is still statistically significant. Thus we argue that tax differences are a significant determinant of the change in the actual price premium, even when we use monthly data and use the GGM to value the two ADRs and estimate the premium. The results for control variables in Table 3.7 are also in line with those in Table 3.5 and therefore are not presented.

This chapter also tests the robustness of the model by adding $ADR\ diff$ in the regressions. Table 3.8 reports the robustness results of the regressions. The tax explanation still holds based on the coefficients on tax dummy variables and the estimated price premium of the GGM. Moreover, the coefficients on $ADR\ diff$ in both Panel A and Panel B are negative and significant at 1%, which is consistent with the hypothesis described in Section 3.5.6. It further improves the credibility of the tax explanation of the BHP mispricing.

[15] Specific details of AR model used to estimate dividends are described in Appendix D.

Table 3.7: Robustness tests of the GGM model

This table reports the robustness results of multivariate OLS Regression in which independent variables are estimated price premium of BHP over Billiton ADRs estimated by the GGM. The dependent variable PR_t is the daily price premium calculated by the daily ratio of BHP ADR price minus daily Billiton ADR price over their average. In Panel A, the independent variable $E[PR_t]$ is the estimated price premium of BHP over Billiton ADRs estimated by the GGM using an estimated annual dividend by the AR model. In Panel B, monthly observations of the estimated price premium are used. X_i stands for 23 control variables are the same as those in Table 3.5 and not shown in this table. The regression uses heteroskedasticity-consistent standard error estimator (Davidson and MacKinnon, 1993) and significance at the 10%, 5% and 1% levels is indicated by *, ** and ***, respectively. T-statistics are reported in parentheses. The sample period is from June 30, 2001 to June 30, 2018.

$$PR_t = \beta_0 + \beta_1 \times E[PR_{GGM,t}] + \Sigma_{i=2}^{23} \beta_i \times X_i + \varepsilon_t, \tag{3.21}$$

	Panel A	Panel B
Intercept	-0.0626***	0.0212
	(-18.405)	(0.956)
$E[PR_t]$	0.7707***	0.3984***
	(58.355)	(3.928)
Observations	2821	125
Adjusted R^2	74.4%	50.2%
F-statistic	390.8	11.43

Table 3.8: Robustness tests with ADR ownership relative difference
This table reports the robustness results of multivariate OLS Regression with ADR ownership relative difference.

$$PR_t = \beta_0 + d_1 * D_1 + d_2 * D_2 + d_3 * D_3 + d_4 * D_4 + d_5 * D_5 + \beta_6 * ADR\,diff + \sum_{i=1}^{23} B_i * X_i + \varepsilon_t, \quad (3.20)$$

$$PR_t = \beta_0 + \beta_1 * E[PR_{GGM,t}] + \beta_2 * ADR\,diff + \sum_{i=1}^{23} B_i * X_i + \varepsilon_t, \quad (3.21)$$

where the independent variables are effective tax difference dummy variables D_{1-5} and the estimated price premium $E[PR_t]$ using the GGM in Panel A and B, respectively. The dependent variable PR_t is the daily price premium calculated by the daily ratio of BHP ADR price minus daily Billiton ADR price over their average. In Panel A, the independent variables are five effective tax difference dummy variables D_{1-5} equaling to one after the first BHP ex-dividend date that follows an effective tax difference change. In Panel B, the independent variable $E[PR_t]$ is the estimated price premium of BHP over Billiton ADRs estimated by the GGM. $ADR\,diff$ is the relative difference of ADR ownership between BHP and Billiton. X_i stand for 23 control variables are the same as those in Table 3.5 and not shown in this table. The regression uses heteroskedasticity-consistent standard error estimator (Davidson and MacKinnon, 1993) and significance at the 10%, 5% and 1% levels is indicated by *, ** and ***, respectively. T-statistics are reported in parentheses. The sample period is from June 30, 2001 to June 30, 2018.

Panel	Panel A	Panel B
Model	Eq. (3.21)	Eq. (3.22)
Intercept	0.0579 ***	0.0172***
	(18.534)	(4.353)
D_1	0.0610***	
	(24.424)	
D_2	0.0154***	
	(8.114)	
D_3	-0.0455***	
	(-18.297)	
D_4	-0.0388***	
	(-12.734)	
D_5	0.0501***	
	(24.348)	
$E[PR_t]$		0.4251***
		(25.035)
$ADR\,diff$	-0.0037***	-0.0024***
	(-9.973)	(-5.036)
Observations	3281	3281
Adjusted R-squared	70%	50.5%
F-statistic	213.8	137.2

3.7 Conclusion and original contribution

This chapter applies a multivariate time-series OLS regression to examine the effects of tax differences between Australia and the UK on price differences (i.e., a premium) between the BHP ADR and the Billiton ADR while controlling for market return, microstructure variables and macro-economic variables identified previously. This regression uses dummy variables for different tax regimes in Australia and the UK as additional independent variables. In separate regressions, we also use the actual premium as the dependent variable and develop a valuation of the two dividend streams using the GGM and the RIM as alternative estimations of our main independent variable, namely the relative estimated valuation of the two ADRs incorporating tax effects. Our findings indicate that the actual ADR premium is significantly and positively correlated with tax differences in both tests.

This chapter contributes to the existing literature in the following aspects. The results provide direct evidence that the mysterious price premium between BHP ADR and Billiton ADR addressed in the previous literature (Froot and Dabora, 1999; Bedi et al., 2003; De Jong et al., 2009; Su et al., 2013) can be significantly explained by tax rules differences between Australia and UK. The price of BHP ADR is higher than Billiton ADR, and this is shown to be due to the differences in imputation (that franking credit rate is 30% in Australia but 10% in the UK). Our findings are in opposition to Bedi et al. (2003) and Froot and Dabora's (1999) proposition that tax differences cannot explain the mispricing between DLC twins. This chapter contributes to the literature to examine the price premium between DLC twins (Rosenthal and Young, 1990; Bodurtha Jr et al., 1995; Froot and Dabora, 1999) by proposing the method of comparing the prices between ADRs of the DLC twins to remove the currency and time zone differences.

Further, this chapter extends the comparative pricing studies literature (Walker and Partington, 1999; McDonald, 2001; Twite and Wood, 2003; Cannavan et al., 2004; Chu and Partington, 2008; Jun et al., 2008; Jun and Partington, 2014) by proposing a method to compare the ADR prices of DLC twins in the comparative pricing studies of franking credits (Walker and Partington, 1999; McDonald, 2001; Twite and Wood, 2003; Cannavan et al., 2004; Chu and Partington, 2008; Jun et al., 2008; Jun and Partington, 2014). Our methodology addresses some of the limitations of comparative pricing studies described in Section 2.4.2, including the misspecified and poor estimate of the valuation of franking credits from derivatives due to transaction costs in futures contracts (McDonald, 2001; Cannavan et al., 2004) and the bias of focussing on the price differential around specific ex-dividend events but ignoring the overall pricing movement in the long term (Siau et al., 2015) as we do not use derivatives and investigate long term price movements of ADRs. The findings also provide indirect evidence on whether the tax rules determine the prices of ADRs in the home market rather than the US. This is consistent with Kadapakkam et al.'s (2010) findings but inconsistent with Jun et al. (2008) and Jun and Partington's (2014) findings.

Theoretically, this chapter modifies the original GGM derived by Gordon and Shapiro (1956) and the original RIM derived by Ohlson (2001) by replacing distributed dividends and residual income with net (after-tax) dividends and net residual income which incorporate personal tax rate and franking credits. This chapter extends the literature of application of the GGM and the RIM as it provides evidence that tax factors should be considered in these two valuation models. Empirically, our research gives traders an insight into the role of taxes as an impediment to arbitrage. Arbitrageurs should consider tax differences as well as other fundamental factors when designing their strategy. Taxation factors might prove to be more significant than other factors such as transaction costs, liquidity constraints, and market index movement in an arbitrage.

Finally, this chapter provides direct evidence to answer the research question of the thesis, whether franking credits are priced in the Australian market, raised in Section 1.2, finding that tax rules significantly explain the price difference between BHP ADR twins. Our finding is consistent with the evidence of some researchers (Brown and Walter, 1986; Brown and Clarke, 1993; Bellamy, 1994; Walker and Partington, 1999; McDonald, 2001; Twite and Wood, 2003; Hathaway and Officer, 1995; Gray, 2008; Minney, 2010; Gray et al., 2011; Vo et al., 2013; Ainsworth et al., 2016b; Cannavan and Gray, 2017). Our findings also contradict the evidence of other researchers (Cannavan et al., 2004; Bellamy and Gray, 2004; Beggs and Skeels, 2006; Feuerherdt et al., 2010).

Further research can be structured to investigate the relationship between the mispricing and US-domiciled ownership holdings of the BHP twins. There are potentially three tax-heterogeneous groups of investors, the first being Australian investors who are eligible for Australian imputation credits, the second being UK investors who are eligible for the UK imputation, and the third group being investors in other countries (e.g., especially the US) who are not eligible for any imputation benefits. Consider an extreme case where the BHP twins are 100% held by all US investors. There should be no tax effects of imputation in these circumstances. On the other hand, the tax effect will be maximised when foreign ownership of BHP and Billiton is zero. Research could be conducted to investigate the proportion of the BHP twins held by ADR investors in the US and the mispricing of the twins.

Chapter 4

Ownership Characteristics and the Pricing of Franking Credits in the Ex-Dividend Period

4.1 Introduction

Ex-dividend price drop-off studies are the most widely used approach in the existing literature, as discussed in Section 2.4.1. A considerable research literature examines the market value of franking credits using ex-dividend price drop-off techniques by regressing the ex-dividend price drop-off on cash dividends and franking credits. For instance, Brown and Clarke (1993), Bellamy (1994), Bellamy and Gray (2004), Hathaway and Officer (1995), Gray (2008), Minney (2010), Vo et al. (2013), Cannavan and Gray (2017) assert that the tax implications, including franking credits, of the dividend payout are of great importance to the ex-dividend price drop. However, their claims are challenged by other literature (Bellamy and Gray, 2004; Beggs and Skeels, 2006; Feuerherdt et al., 2010), which argues that around the ex-dividend date there is no connection between the dividend price drop-off and the level of franking credits. While most previous literature focuses on the direct impact of franking credits on the price drop-off on the ex-dividend date, its overall influence for the whole period surrounding the ex-dividend date has been ignored to date. This chapter contributes to the existing ex-dividend date studies literature by examining the impact of dividends and franking credits surrounding the ex-dividend date using a longer horizon.

The research question of this chapter arises from the phenomenon of order imbalance from the buy-side prior to the ex-dividend date and sell-side afterwards documented by some papers (Eades et al., 1984; Brown and Clarke, 1993; Bellamy, 2002; Ainsworth, Fong, Gallagher, and Partington, 2018). This phenomenon is referred to as the "ex-dividend period irrational exuberance" (i.e., a price run-up before the ex-dividend date and a price run-down after the ex-dividend date) in this thesis. Accordingly, this chapter extends the ex-dividend date studies by relating the ex-dividend period of irrational exuberance with dividend clienteles and franking credits in Australia in the following three progressive questions: (1) Does the ex-dividend period irrational exuberance exist in the Australian equity market? (2) Do dividend clienteles exist in the Australian equity market? (3) What is the role of franking credits in dividend clienteles?

This chapter first validates the existence of the ex-dividend period irrational exuberance in the Australian equity market. This chapter verifies the irrational exuberance by examining the abnormal adjusted returns surrounding the ex-dividend date and relates it with dividends and franking credits. Compared with previous literature (Eades et al., 1984; Brown and Clarke, 1993; Bellamy, 2002; Ainsworth et al., 2018) that usually use a 5-day window, this chapter extends the existing literature by using a wider range of investigating windows (5-day, 10-day, 20-day, 30-day, 40-day, 50-day).

This chapter further investigates the existence of dividend clienteles in the Australia equity market. Although Miller and Morey (1996) believe that dividend policy does not affect share prices in a perfect market, they also admit that, with market imperfections, dividend clienteles exist, suggesting that firm's dividend policy affects share price due to investor characteristics. The tax-induced explanation of dividend clienteles claims that tax-incentives motivate trading decisions around the ex-dividend date (Feldstein and Green, 1983; Shleifer and Vishny, 1986; Redding, 1997; Brav and Heaton, 1998; Allen et al., 2000). In Australia, the introduction of CGT concessions in 1999 described in Section 2.2.6 (i.e., capital gains for asset held for more than 12 months are taxed as half of the personal income for individual investors, but two-thirds of the personal income for institutional investors (Australian Taxation Office, 2018)) creates a tax-disadvantage to institutional investors compared to individual investors on capital gains. This tax-disadvantage could intuitively lead to institutional investors' preference for dividends and franking credits. Following Elton and Gruber's (1970b) methodology that relates the dividend drop-off ratio with tax-induced clienteles, a considerable number of research papers attempt to confirm this tax-driven relationship. However, most existing empirical evidence is US-based (where a classical tax system prevails). Only limited studies (Jun, Gallagher, and Partington, 2006; Ainsworth, Fong, Gallagher, and Partington, 2016a) focus on the Australian equity market, and the evidence is mixed. This motivates us to investigate the existence of dividend clienteles in Australia.

Theoretically, contrary to the tax-induced explanation dividend clienteles, this chapter proposes a behavioural finance explanation of "individual dividend clienteles" in which individual investors overvalue the dividends and franking credits due to the "bird in the hand" fallacy, the "behavioural life-cycle" theory, and the "information signaling" theory. The "bird in the hand" fallacy claims that risk-averse investors prefer dividends to capital gains as dividends are more certain than capital gains (Gordon, 1963; Lintner, 1964). In addition, less sophisticated investors are more likely to fall into the "bird in the hand" fallacy given their lack of expertise and resources to observe market price movements closely (Dennis and Strickland, 2002; Barber and Odean, 2013). The "behavioural life-cycle" theory states that particular categories of investors (e.g., retirees) prefer dividends as their income heavily relies on dividends (Shefrin and Statman, 1984). The "information signaling" theory suggests that individual investors are more affected by the signaling role of dividends due to their limited information sources (Bhattacharya, 1979).

Empirically, by examining the statistical relationship between the extent of the irrational exuberance and the level of ownership holdings, we find evidence of individual dividend clienteles that is opposite to the tax-induced explanation but consistent with the behavioural finance explanation. In particular, firms with a higher percentage of individual investor holdings experience a more substantial ex-dividend period irrational exuberance. Further, the percentage of international ownership is not related to irrational exuberance. Therefore, the ex-dividend period irrational exuberance can be explained by the behavioural finance explanation of dividend clienteles. Finally, we further seek to analyse the role of franking credits in dividend clienteles. Specifically, we incorporate franking credits in the ex-dividend period irrational exuberance and the behavioural finance explanation of dividend clienteles. Empirically, we again find that individual investors tend to place more value on franking credits than do institutional investors.

The reminder of this chapter is organized as follows. Section 4.2 summarises related theoretical and empirical literature on ex-dividend day pricing and dividend clienteles leading to the hypothesis development. Section 4.3 and Section 4.4 detail data collection and methodology. Section 4.5 presents the empirical results. Section 4.6 concludes this chapter.

4.2 Literature review

The literature review consists of six parts. Section 4.2.1 reviews the tax differences between capital gains and dividends in the Australian imputation system discussed in Section 2.2.6. Section 4.2.2 reviews the literature on the ex-dividend period irrational exuberance. Section 4.2.3 reviews the literature on dividend clienteles internationally. Section 4.2.4 and Section 4.2.5 illustrate the empirical evidence and the theoretical explanations of dividend clienteles in Australia. Section 4.2.6 states the research question.

4.2.1 Review of capital gain tax

As discussed in Section 2.2.6, after the replacement of the "indexation method" with "discount method" in CGT rules in 1999, superannuation funds are tax-advantaged in capital gains (23.5%) relative to dividend income (47%) while superannuation funds are tax-disadvantaged in capital gains (10%) relative to dividends income (15%).

4.2.2 Ex-dividend period irrational exuberance

As discussed in Section 2.4.1.2, ex-dividend date studies are most commonly used to examine the value of franking credits by regressing the ex-dividend drop-off on the value of franking credits and dividends. This evidence is, however, mixed, and the empirical method has some limitations. One main limitation of ex-dividend date studies is the poor estimate of franking credits' valuation from the ex-dividend days for long-term investors (McDonald, 2001). Early studies document an abnormal exuberance during a 5-day window surrounding the ex-dividend date (Eades et al., 1984; Brown and Clarke, 1993; Bellamy, 2002; Ainsworth et al., 2018). Most previous literature commonly examines the direct impact of franking credits on the ex-dividend date or price movements during a shorter window surrounding the ex-dividend date. To overcome this limitation, this chapter investigates the ex-dividend period irrational exuberance using a wider range of windows, including 5-day, 10-day, 20-day, 30-day, 40-day, and 50-day. The following hypotheses are made to verify the existence of the exuberance.

Hypothesis 4.1: *There is an irrational exuberance surrounding the ex-dividend date.*

This chapter further links the ex-dividend period irrational exuberance with dividends. The relationship is hypothesised to be positive because investors are more likely to purchase shares prior to the ex-dividend date and sell them afterwards to obtain dividends if the level of the dividend is larger. Therefore, hypothesis 4.2 is made. If franking credits are priced as dividends, hypothesis 4.3 can also be stated.

Hypothesis 4.2: *The magnitude of the ex-dividend period irrational exuberance is positively correlated to the level of dividends.*

Hypothesis 4.3: *The magnitude of the ex-dividend period irrational exuberance is positively correlated to the level of franking credits.*

4.2.3 Dividend clienteles internationally

The theoretical literature provides insights about dividend clienteles suggesting that institutional investors prefer dividends to capital gains. Elton and Gruber (1970b) first argue that dividend clienteles can be caused by the differences in taxation between dividend income and capital gains, and individual investor's tax preferences. Based on previous dividend clientele theories, institutional investors should prefer dividends to capital gains due to two reasons. First, there is a tax reason; institutional investors are attracted to dividends since they are usually tax-advantaged in dividends relative to capital gains (Feldstein and

Green, 1983; Shleifer and Vishny, 1986; Redding, 1997; Brav and Heaton, 1998; Allen et al., 2000; Felixson and Liljeblom, 2008; Rantapuska, 2008). Second, there are non-tax reasons; institutional managers avoid holding shares in non-dividend paying firms and prefer investing in dividend-paying firms due to the "prudent-man" rule[1] and restrictions in the investment mandates of fiduciaries and non-profit organisations (Feldstein and Green, 1983; Brav and Heaton, 1998).

Compared to the theoretical literature, empirical studies are more mixed, varying depending on the countries and taxation systems examined. Hu and Tseng (2006) investigate order flows during the ex-dividend period on the Taiwan Stock Exchange, which has an imputation system where the corporate tax rate is 25%, and the franking credit rate is 33.3%. They find evidence consistent with the tax hypothesis by documenting that tax-disadvantaged investors avoid trading around the ex-dividend date and institutional investors purchase before and sell after the ex-dividend date. Researchers have also analysed the trading pattern of all investors in the uniquely data-rich Finnish stock market and found that dividend tax-advantaged domestic individuals prefer cash dividends while international investors and domestic institutions prefer capital gains, which is consistent with tax-induced explanations (Feldstein and Green, 1983; Shleifer and Vishny, 1986; Redding, 1997; Brav and Heaton, 1998; Allen et al., 2000; Felixson and Liljeblom, 2008; Rantapuska, 2008). However, there is also literature with contrasting findings. Grinstein and Michaely (2005) report that institutions prefer firms with dividends, but they are not attracted to higher dividends. Jain (2007) suggests that individual investors tend to hold high dividend yield securities, whereas relatively lower-taxed institutional investors prefer to invest in low and zero dividend yield stocks in the US.

4.2.4 Empirical evidence of dividend clienteles in Australia

Most of the empirical evidence of dividend clienteles is based on data drawn from US markets. In Australia, the literature, by comparison, is scarce, albeit most of these studies produce results that contradict the tax-induced explanation, as discussed below. Australia is quite different from other countries with classical tax systems because franking credits are an inevitable complication and a significant factor contributing to tax heterogeneity. Although higher dividends might not attract more clienteles, the availability of franking credits does. Jun et al. (2006) investigate institutional equity funds and provide evidence that institutional investors prefer dividend-paying stocks. However, they find little evidence that institutions prefer firms with higher dividends and document an inverted U shape relationship between institutional holdings and the dividend payout ratio (or dividend yield). They examine the valuation of franking credits by regressing institutional

[1]The Prudent man rule originates from Massachusetts court formulation, which suggests that each investment must be valued on its own merits and speculative or risky investments should be prohibited (Del Guercio, 1996).

ownership on a franked dummy and show that institutional investors tend to hold stocks with fully franked dividends relative to those having no franking credits. Ainsworth et al. (2016a) examine the trading pattern of institutional equity funds by accessing their trading records and find evidence that institutional investors prefer capital gains to dividends and franking credits in Australia. Their results are consistent with the evidence provided by previous literature in the US (Grinstein and Michaely, 2005; Jain, 2007). The availability of franking credits, changes in tax incentives, the price run-up in the cum-dividend period, and the fund's tax status all influence the ex-dividend day trading. To conclude, the literature on the dividend clienteles incorporating franking credits in Australia is limited and somewhat mixed, and there is insufficient evidence to support the tax-induced explanation of dividend clienteles.

4.2.5 Theoretical explanations of dividend clienteles in Australia

Contrary to tax-induced explanations of dividend clienteles, this chapter proposes the behavioural finance explanations, including the "bird in the hand" fallacy, the "behavioural life-cycle" theory, and the "information signaling" theory, to the individual dividend clienteles that individual investors overvalue dividends and franking credits. The "bird in the hand" fallacy is proposed by Gordon (1963) and Lintner (1964), who claim that risk-averse investors prefer dividends to capital gains as dividends are more certain than capital gains. Dennis and Strickland (2002) and Barber and Odean (2013) add that less sophisticated investors are more likely to suffer from the "bird in the hand" fallacy given their lack of expertise (such as in-depth financial knowledge in building diversified portfolios) and resources (such as time and fees to acquire financial advice) to observe market price movements closely. Another explanation is Shefrin and Statman's (1984) "behavioural life-cycle" theory that dividends are preferred by certain groups of investors (specifically, retirees) who are likely to depend on dividends as a source of income. Dong, Robinson, and Veld (2005) note that older people and/or those who do not have stable incomes are likely to fall into the above category. Graham and Kumar (2006) show that older and lower-income people prefer dividends in a study using US data. Further, the "information signaling" theory proposed by Bhattacharya (1979) can also explain the preference. He argues that an increase or decrease in distributed dividends signals the future performance of a company. Individual investors are more likely to be influenced by the signaling role of dividends as their information sources are limited.

According to the behavioural finance theories described above, individual investors prefer dividends and franking credits due to the "bird in hand" fallacy, the "behavioural life-cycle" theory, and the "information signaling" theory, thus contributing to the ex-dividend period irrational exuberance. Therefore, the level of individual ownership should be positively related to the magnitude of the ex-dividend period irrational exuberance. Accordingly, hypothesis 4.4 is developed to relate individual ownership with the exuberance.

Hypothesis 4.4: *The magnitude of the ex-dividend period irrational exuberance is positively correlated to the level of individual ownership.*

Compared with individual holdings, the literature investigating the impact of international holdings on ex-dividend date studies is particularly scarce in the Australian market for two reasons. First, the percentage of international ownership in many Australian companies is generally very low (0.79%[2]) during the period between January 1, 2006 and December 31, 2014, and hence it has limited influence on the share prices. Second, data on international ownership are not readily accessible. Therefore, hypothesis 4.5 is described below as the level of international ownership is extremely low.

Hypothesis 4.5: *The magnitude of the ex-dividend period irrational exuberance is insignificantly related to the percentage of international ownership of the firm.*

Further, this chapter verifies the existence of individual dividend clienteles by examining the impact of individual ownership on the relationship between dividends/franking credits and the ex-dividend period irrational exuberance addressed in hypotheses 4.2 and 4.3. According to the individual dividend clienteles discussed above, individual investors prefer dividends/franking credits to capital gains, thus contributing to the ex-dividend period irrational exuberance[3]. Therefore, hypotheses 4.6 that a firm's individual ownership level strengthens the positive relationship between the irrational exuberance and dividends/franking credits is developed.

Hypothesis 4.6: *The percentage of individual ownership strengthens the positive relationship between the magnitude of the ex-dividend period irrational exuberance and the level of the dividend.*

Finally, this chapter examines the role of franking credits in the individual dividend clienteles. If hypothesis 4.6 holds and franking credits are priced as dividends in the market, hypothesis 4.7 should hold as well.

[2]The rate is from Panel A in Table 4.5.1

[3]"Irrational exuberance" is mainly caused by domestic individual investors' preference for franking credits and dividends due to "bird in hand theory", the "behavioural life-cycle" theory, and the "information signaling" theory as described in Section 4.2.5. Domestic institutional investors are less prone to these characteristics, as they are more rational and sophisticated. More importantly, as individual investors buy shares during the cum-dividend period, other investors, including domestic institutional investors reduce their holding as a natural consequence. Individual "irrational exuberance" should be related to the investors' marginal tax rate. For example, investors with a marginal tax rate that is lower than the franking credit tax rate could have a higher preference to franking credits as they are eligible for a cash refund of the difference as a part of their tax calculation.
From Fig. 4.2, we find that firms with a higher individual investors have larger price rises during the cum-dividend period. This indicates that the main cause of the price increase is domestic individual investors rather than Australian domestic superannuation investors. Further, in Table 4.3, the positive and significant coefficient on INDO (the percentage of individual ownership during the cum-dividend period) and the negative and significant coefficient on EX*INDO (the percentage of individual ownership during the ex-dividend period) also support this argument.

Hypothesis 4.7: *The percentage of individual ownership strengthens the positive relationship between the magnitude of the ex-dividend period irrational exuberance and the level of franking credits.*

4.2.6 Research question

Does the ex-dividend period irrational exuberance exist in the Australian equity market? This chapter extends the previous literature (Eades et al., 1984; Brown and Clarke, 1993; Bellamy, 2002; Ainsworth et al., 2018) by identifying the exuberance using a longer examining window surrounding the ex-dividend date. Do dividend clienteles exist in the Australian equity market? The literature regarding this question is limited and mixed (Jun et al., 2006; Ainsworth et al., 2016a). This chapter provides evidence as to the existence of behavioural finance explanations of individual dividend clienteles. What is the role of franking credits in the dividend clienteles? The answer to this question extends the existing ex-dividend date studies literature that examines the valuation of franking credits (Brown and Clarke, 1993; Bellamy, 1994; Bellamy and Gray, 2004; Hathaway and Officer, 1995; Bellamy and Gray, 2004; Beggs and Skeels, 2006; Gray, 2008; Feuerherdt et al., 2010; Minney, 2010; Vo et al., 2013; Cannavan and Gray, 2017). Overall, this chapter extends the existing ex-dividend date studies literature by verifying the existence of the ex-dividend period irrational exuberance using a longer examining window, providing evidence on the dividend clienteles, further examining the role of franking credits in dividend clienteles, and therefore ultimately providing evidence to the debate on whether franking credits are priced in the Australian equity market.

4.3 Data collection

The study is based on all dividend-paying stocks traded on ASX over the period January 1, 2006 through to December 31, 2014. Dividend data including the ex-dividend date, the dollar amount of dividend per share, the franking level, and franking credits per share are sourced from Australian Share Price and Price Relative (SPPR) Database held within the Securities Industry Research Centre of Asia-Pacific (SIRCA). In addition, the split ratio that contains splits, rights, and entitlements is also collected from SPPR. SPPR database provides monthly share prices, dividends including franking credits, adjustments for share issues and reconstructions, the number of shares on issue, and price relatives. Also, ticker changes and merger/delisting information are provided from 1973 for all Australian listed and previously listed companies. During the sample period, there were 10,332 ex-dividend events for 1,207 firms. A sample inclusion screen was used: for a dividend event to be included, the stock must have closing prices on the ex-dividend date and the cum-dividend date. This screen reduces the number of ex-dividend days to

9,699 for 1,122 firms. Among all ex-dividend events, 5,936 events are fully franked, 628 are partly franked, and 3,135 are unfranked. The average franking level is 64.42%.

End of day data including the close prices of securities and Australian All Ordinaries Accumulation Index (XAOA) and full order book data are sourced from Thomson Reuters Tick History (TRTH) and Australian Equities Tick History (AETH). TRTH is a nearly real-time historical market database that provides millisecond-time stamped tick data going back to 1996 for 45 million global active OTC and exchange-traded instruments. AETH offers a narrower pool of Australian equities but a longer history that goes back to 1991. The daily close prices of securities and the index, together with split ratio, are used to calculate the daily abnormal adjusted return, as described in Section. 4.4.1.1. The number of shares held by individual investors, institutional investors, domestic investors, and international investors on a daily basis are obtained from the ASX's Clearing House Electronic Sub-register System (CHESS) database. CHESS provides an electronic sub-register for shares traded on ASX. Investors are divided into nine categories, namely banks, other deposit-taking institutions, nominees, insurance companies, super funds, trusts, governmental agencies, incorporated companies, and individuals. The number of shares held by institutional investors is the sum of all holdings in the first eight categories, while the number of shares held by individual investors is the last category. In addition, these nine categories are further divided into domestic versus international investors leading to 18 categories in total. The calculation of shareholdings is implemented by ASX after ASX approved a confidential data request lodged with the SIRCA Data Consult team[4]. The calculation of the percentage of individual ownership and international ownership is described in 4.4.1.2. Accounting data including total shareholders' equity (TSE), market capitalisation (MC), and earnings per share (EPS) are obtained from Thomson Reuters DataStream.

[4]Tanza (2014) also analyses franking balance and measures the percentage of international ownership of firms in S&P/ASX100 in Australia provided by CHESS from 1996 to 2003. His findings show that the percentage of international ownership averages at 0.30%, which is at a similar level as our findings of 0.79%. More importantly, CHESS holdings represent legal ownership of equity and are thus an extremely validated source of data. While some errors might have occurred in the word-searching algorithm used by ASX to form categories of ownership, and while the beneficial ownership of holdings in the nominee category is unclear, CHESS data remain as an accurate daily record of ownership of Australian listed firms.

4.4 Methodology

4.4.1 Variable description

4.4.1.1 Abnormal adjusted return

Daily abnormal adjusted return (AAR) is the return of daily closing prices after adjusting capitalisation changes and subtracting the return on the XAOA as:

$$AAR_{s,d} = (\frac{(CLS_{s,d} + DPS_{s,d})/SR_{s,d}}{CLS_{s,d-1}} - \frac{XAOA_d}{XAOA_{d-1}} - 1) * 100\%, \tag{4.1}$$

where $AAR_{s,d}$ is the daily abnormal adjusted return for security s on date d, $CLS_{s,d}$ is the daily close price for security s on date d, $DPS_{s,d}$ is dividend[5] per share for security s on date d, $SR_{s,d}$ is the split ratio for security s on date d, $XAOA_d$ is the price of XAOA on date d.

The average abnormal adjusted return $\overline{AAR}$ around the ex-dividend date is used to proxy for the magnitude of the ex-dividend period irrational exuberance, after controlling for the influence of dividends, splits, rights, and entitlements as well as the impact of the market return. $\overline{AAR}$ consists of average returns over three periods including the cum-dividend period ($\overline{AAR_{cum}}$), the ex-dividend period ($\overline{AAR_{ex}}$), and the ex-dividend date ($\overline{AAR_{div}}$). They are calculated as the arithmetic average of ($AAR_{s,d}$) over various periods for interval i as:

$$\overline{AAR_{s,n,p,i}} = \frac{\sum_{d \in DATES_{s,n,p,i}} AAR_{s,d}}{N_{DATES_{s,n,p,i}}}, \tag{4.2}$$

where $\overline{AAR_{s,n,p,i}}$ is the average daily abnormal adjusted return for security s and dividend n during period p with interval i, p can be the cum-dividend period, the ex-dividend period, or the ex-dividend date, i is the interval of average return that could be 5-day, 10-day, 20-day, 30-day, 40-day, and 50-day for the cum-dividend period or the ex-dividend period but will always be one day for the ex-dividend date, $DATES_{s,n,p,i}$ is a set of all dates for security s for dividend n during period p with interval i, $N_{DATES_{s,n,p,i}}$ is the number of dates in particular $DATES_{s,n,p,i}$.

This general formula can be expanded to three equations as:

$$\overline{AAR_{s,n,cum,i}} = \frac{\sum_{d \in DATES_{s,n,cum,i}} AAR_{s,d}}{N_{DATES_{s,n,cum,i}}}, \tag{4.3}$$

$$\overline{AAR_{s,n,ex,i}} = \frac{\sum_{d \in DATES_{s,n,ex,i}} AAR_{s,d}}{N_{DATES_{s,n,ex,i}}}, \tag{4.4}$$

$$\overline{AAR_{s,n,div,i}} = AAR_{s,div}, \tag{4.5}$$

[5] Dividend represents cash dividends only and not cash dividend plus franking credits.

where $\overline{AAR_{s,n,cum,i}}$ is the average daily abnormal adjusted return for security s and dividend n during the cum-dividend period with interval i, $\overline{AAR_{s,n,ex,i}}$ is the average daily abnormal adjusted return for security s and dividend n during the ex-dividend period with interval i, $\overline{AAR_{s,n,div,i}}$ is the average daily abnormal adjusted return for security s and dividend n on the ex-dividend date, $DATES_{s,n,cum,i}$ is the set of all dates for security s for dividend n during the cum-dividend period with interval i, $DATES_{s,n,ex,i}$ is the set of all dates for security s for dividend n during the ex-dividend period with interval i, $N_{DATES_{s,n,cum,i}}$ is the number of dates in particular $DATES_{s,n,cum,i}$, $N_{DATES_{s,n,ex,i}}$ is the number of dates in particular $DATES_{s,n,ex,i}$, $AAR_{s,div}$ is the abnormal adjusted return on the ex-dividend date. In particular, Eq. (4.3), Eq. (4.4), and Eq. (4.5) describe that average daily abnormal adjusted returns for cum-dividend period, ex-dividend period, and the ex-dividend date are calculated by the sum of abnormal adjusted returns divided by the number of dates in the cum-dividend period, ex-dividend period and the ex-dividend date respectively.

4.4.1.2 Ownership holdings

The percentage of individual ownership $(INDO)$ is the percentage of individual ownership calculated as the ratio of the number of shares owned by individual investors over the number of shares outstanding:

$$INDO_{s,d} = \frac{NSIND_{s,d}}{NSOUT_{s,d}}, \tag{4.6}$$

where $NSIND_{s,d}$ is the number of shares held by individual investors for security s on date d, $NSOUT_{s,d}$ is the number of shares outstanding for security s on date d. $INDO$ serves as the proxy for the level of individual ownership. The percentage might not be a completely accurate measure of total ownership as only shares registered on the CHESS sub-register are taken into account[6]. Similarly, the percentage of international ownership $(INTO)$ is used as the proxy for the level of international ownership. $INTO$ is the percentage of international ownership calculated as the ratio of the number of shares owned by international investors over the number of shares outstanding:

$$INTO_{s,d} = \frac{NSINT_{s,d}}{NSOUT_{s,d}}, \tag{4.7}$$

where $NSINT_{s,d}$ is the number of shares held by international investors for security s on date d.

In addition, the sample is sorted into terciles depending on $INDO$ and $INTO$, respectively. We construct the dummy variable $(D_{INDO_{s,d}}/D_{INTO_{s,d}})$ that takes the value one if $INDO/INTO$ is above the higher (67%) tercile and zero if it is below the lower (33%)

[6]It is possible to remove this bias by retrospective inspection of the firm's share register. This is, however, extremely costly and hence not practical.

tercile across all firms for each year.

$$D_{INDO_{s,d}} = \begin{cases} 0, & \text{INDO is below the lower (33\%) tercile of INDO} \\ 1, & \text{INDO is above the higher (67\%) tercile of INDO,} \end{cases} \tag{4.8}$$

$$D_{INTO_{s,d}} = \begin{cases} 0, & \text{INTO is below the lower (33\%) tercile of INTO} \\ 1, & \text{INTO is above the higher (67\%) tercile of INTO.} \end{cases} \tag{4.9}$$

4.4.1.3 Dividend variables

Following the existing empirical literature, we use the dividend payout ratio (DPR)[7] and the dividend yield (DY) to proxy for dividends (Jun et al., 2006; Ainsworth et al., 2016a). DPR is calculated by using dividend per share divided by earnings per share in the previous year as:

$$DPR_{s,d} = \frac{DPS_{s,d}}{PEPS_{s,d}}, \tag{4.10}$$

where DPS is dividend per share for security s on date d, $PEPS$ is earnings per share of the previous year for security s on date d.

DY is measured by the dollar amount of dividend per share, divided by the cum-dividend day closing price shown as:

$$DY_{s,d} = \frac{DPS_{s,d}}{CLS_{s,d}}. \tag{4.11}$$

4.4.1.4 Franking credits variables

We follow previous studies to measure franking credits by franking credits per share (FPS), franking credits dividend ratio (FDR), franking level (FL), franked dummy (FD), and franking credit yield (FCY) (Jun et al., 2006; Ainsworth et al., 2016a).

FPS is the dollar amount of franking credits per share.

FDR is the dollar amount of franking credits per share divided by the dollar amount of dividend per share, which is defined as:

$$FDR_{s,d} = \frac{FPS_{s,d}}{DPS_{s,d}}, \tag{4.12}$$

where FPS is franking credits per share for security s on date d.

FL is 0 if the dividend is unfranked while it is 100 if the dividend is fully franked. It can range between 0 and 100 if the dividend is partly franked.

FD is a dummy variable that takes the value of one if the dividend is fully franked and

[7]If earnings per share are negative, the dividend payout ratio would be one; if the dividend payout ratio is higher than 10, it would be set to 10.

zero if it is unfranked or partly franked shown as:

$$FD_{s,d} = \begin{cases} 1, & FL > 0 \\ 0, & FL = 0. \end{cases} \tag{4.13}$$

FCY is the dollar amount of franking credits per share, divided by the cum-dividend closing price as:

$$FCY_{s,d} = \frac{FPS_{s,d}}{CLS_{s,d}}. \tag{4.14}$$

4.4.1.5 Ex dummy

EX is a dummy variable that takes the value of one when the return is during the ex-dividend period and zero if it is during the cum-dividend period.

$$EX_d = \begin{cases} 0, & \text{date is in the cum-dividend period} \\ 1, & \text{date is in the ex-dividend period} \end{cases} \tag{4.15}$$

4.4.1.6 Control variables

Log of market capitalisation (LMC) is defined as the natural log of market capitalisation on December 31 of the previous year. A log-transformation is used as a proxy for firm size because market capitalisation is highly skewed. Firm size is controlled for because small-cap firms have been shown to have higher returns, i.e., the “small-cap” anomaly (Fama and French, 1995). Book to market ratio (BM) is the ratio of the book value of equity to the market value of a firm’s equity. The book to market ratio is added in the controls because it has been shown that stock returns are higher for firms with higher book to market ratio, i.e., the “growth vs. value” anomaly (Fama and French, 1995). Quoted spread (QSP) is used to proxy for transaction costs. The time-weighted quoted spread is measured as the time-weighted average of limit order bid-ask spread based on the approach adopted in McInish and Wood (1992). Intraday volatility ($IVOL$) is calculated as the standard deviation of the return based on mid-point price for each quote update.

4.4.2 Model Specification

4.4.2.1 Model one

The first model validates the existence of the ex-dividend period irrational exuberance and examines its relationship with dividends/franking credits. The OLS regression model regresses the average daily abnormal adjusted return $\overline{AAR}$ on EX, dividend variables DV, franking credits variables FCV, and their interactions while controlling for microstructure and accounting variables.

$$\begin{aligned}\overline{AAR_{s,n,d}} =& \beta_0 + \beta_1 * EX_{s,n,d} + \beta_2 * DV + \beta_3 * EX_{s,n,d} * DV + \beta_4 * FCV + \beta_5 * EX_{s,n,d} * FCV \\ & + \beta_6 * LMC_{s,d} + \beta_7 * BM_{s,d} + \beta_8 * QSP_{s,d} + \beta_9 * IVOL_{s,d} + \varepsilon_{s,d}.\end{aligned} \tag{4.16}$$

According to hypothesis 4.1, β_0 is expected to be positive and β_1 is expected to be negative. According to hypothesis 4.2, β_2 is expected to be positive and β_3 is expected to be negative. According to hypothesis 4.3, β_4 is expected to be positive and β_5 is expected to be negative.

4.4.2.2 Model two

The second model examines the relationship between the ex-dividend period irrational exuberance and ownership holdings. The OLS regression model regresses the average daily abnormal adjusted return $\overline{AAR}$ on EX, $INDO$ / $INTO$ and their interactions with EX while controlling for dividend, microstructure, and accounting variables.

$$\begin{aligned}\overline{AAR_{s,n,d}} =& \beta_0 + \beta_1 * EX_{s,n,d} + \beta_2 * INDO_{s,d} + \beta_3 * EX_{s,n,d} * INDO_{s,d} \\ & + \beta_4 * INTO_{s,d} + \beta_5 * EX_{s,n,d} * INTO_{s,d} + \beta_6 * DY_{s,d} \\ & + \beta_7 * LMC_{s,d} + \beta_8 * BM_{s,d} + \beta_9 * QSP_{s,d} + \beta_{10} * IVOL_{s,d} + \varepsilon_{s,d}.\end{aligned} \tag{4.17}$$

According to hypothesis 4.4, β_2 is expected to be positive and β_3 is expected to be negative. According to hypothesis 4.5, β_4 and β_5 are expected to be insignificant.

4.4.2.3 Model three

The third model validates the existence of the individual dividend clienteles by examining the impact of individual ownership on the relationship between dividends/franking credits and the ex-dividend period irrational exuberance. The OLS regression model regresses the average daily abnormal adjusted return $\overline{AAR}$ on EX, individual ownership dummy D_{INDO}, dividend variables DV, franking credits variables FCV, and their interactions while controlling for dividend variable, microstructure, and accounting variables.

$$
\begin{aligned}
\overline{AAR_{s,n,d}} = & \beta_0 + \beta_1 * EX_{s,n,d} + \beta_2 * DV + \beta_3 * EX_{s,n,d} * DV + \beta_4 * FCV + \beta_5 * EX_{s,n,d} * FCV \\
& + \beta_6 * D_{INDO_{s,d}} + \beta_7 * EX_{s,n,d} * D_{INDO_{s,d}} \\
& + \beta_8 * DV * D_{INDO_{s,d}} + \beta_9 * EX_{s,n,d} * DV * D_{INDO_{s,d}} \\
& + \beta_{10} * FCV * D_{INDO_{s,d}} + \beta_{11} * EX_{s,n,d} * FCV * D_{INDO_{s,d}} \\
& + \beta_{12} * LMC_{s,d} + \beta_{13} * BM_{s,d} + \beta_{14} * QSP_{s,d} + \beta_{15} * IVOL_{s,d} \\
& + \varepsilon_{s,d}.
\end{aligned}
\tag{4.18}
$$

According to hypothesis 4.6, β_8 is expected to be positive and β_9 is expected to be negative. According to hypothesis 4.7, β_{10} is expected to be positive and β_{11} is expected to be negative.

4.5 Empirical results

4.5.1 Summary statistics

Table 4.1 shows summary statistics for the dividend events in our sample. The magnitudes and dispersions of the variables are examined. The full sample contains 9,699 dividend events, among which 5,936 (61.2%) are fully franked dividends, 3,135 (32.3%) are unfranked dividends, with the remaining 628 (6.4%) being partly franked dividends. Panel A shows the statistics for the full sample. The average amount of dividends is 13.2680 cents, with a dividend payout ratio of 60.7305%. The average amount of franking credits is 3.9197 cents, and the franking credits dividend ratio is 27.6102%. The average AAR in the 50-day window is 0.1203% during the cum-dividend period, -0.0052% during the ex-dividend period, and 0.5109% on the ex-dividend date. The finding is consistent with previous findings of order imbalance from the buy-side (Eades et al., 1984; Brown and Clarke, 1993; Bellamy, 2002; Ainsworth et al., 2018) and thus confirms the existence of the ex-dividend period irrational exuberance. Panel B provides the statistics for the sample of fully franked dividends in which the average AAR during the 50-day cum-dividend period, during the 50-day ex-dividend period and on the ex-dividend date are 0.1312%, -0.0197%, and 0.3428% respectively. Compared with the full sample, the sample of fully franked dividends with a higher amount of dividends and franking credits have a higher average AAR before the ex-dividend date but a lower average AAR after the ex-dividend date. Panel C describes the statistics for the sample of partly franked dividends. The average AAR during the 50-day window shifts from 0.1567% to -0.027% after stocks go ex-dividend. For unfranked dividends shown in Panel D, the average AAR during the

50-day window decreases from 0.0924% to 0.027% after the ex-dividend date. Overall, all panels provide evidence that the magnitude of the ex-dividend period irrational exuberance decreases with the level of franking credits attached with dividends (from fully franked dividends to unfranked dividends). Overall, the results of the summary statistics confirm hypotheses 4.1, 4.2, and 4.3.

Table 4.1: Summary statistics

This table reports mean, median, standard deviation, minimum and maximum of dividend data, ownership data, and return data. Dividend is the dollar amount of dividend. Dividend payout ratio is the dollar amount of dividend per share divided by earnings per share. Dividend yield is the dollar amount of dividend per share divided by the cum-dividend closing price. Franking level would be 0 if the dividend is unfranked while it would be 100 if the dividend is fully franked, and it could be between 0 and 100 if the dividend is mixed. Franking credits per share is the dollar amount of franking credits per share. Franking credits dividend ratio is the dollar amount of franking credits to the dollar amount of dividend per share. Franking credits yield is the dollar amount of franking credits divided by the closing price on the ex-dividend date. Average abnormal adjusted return is the average daily abnormal adjusted return on the ex-dividend date, during the cum-dividend period, and the ex-dividend period using a 50-day window. The percentage of individual ownership is the ratio of the number of shares owned by individual investors over the number of shares outstanding. The percentage of international ownership is the ratio of the number of shares owned by international investors over the number of shares outstanding. The sample contains 9699 dividend events between January 1, 2006 and December 31, 2014.

Variable	Mean	Median	Std.	Min.	Max.	N.
Panel A: full sample						
Dividend (cents)	13.2680	5.0000	38.2628	0.0200	2800.0000	9699
Dividend payout ratio (%)	60.7305	37.8305	100.7562	0.0012	1000.0000	9699
Dividend yield (%)	3.5311	2.4060	26.3959	0.0232	2366.8421	9699
Franking level (%)	64.4237	100.0000	46.5345	0.0000	100.0000	9699
Franking credits per share (cents)	3.9197	1.0329	15.5275	0.0000	1200.0000	9699
Franking credits dividend ratio (%)	27.6102	42.8571	19.9433	0.0000	42.8571	9699
Franking credits yield (%)	0.8586	0.6878	2.7146	0.0000	207.6923	9699
Percentage of individual ownership (%)	44.5891	41.3808	25.1800	0.0273	99.9969	9699
Percentage of international ownership (%)	0.7946	0.3209	2.5776	0.0003	85.2861	9699
50-day cum-dividend period average abnormal adjusted return (%)	0.1203	0.0566	1.9200	-2.9941	132.4200	9669
Ex-dividend date abnormal adjusted return (%)	0.5109	0.1193	4.3397	-31.4609	145.3322	9444
50-day ex-dividend period average abnormal adjusted return (%)	-0.0052	-0.0224	1.4786	-3.7177	141.0012	9657
Panel B: fully franked dividend sample						
Dividend (cents)	13.7645	5.0000	45.2022	0.0200	2800.0000	5936
Dividend yield (%)	3.1280	2.4691	7.8573	0.0893	484.6154	5936
Dividend payout ratio (%)	59.4349	38.3632	98.7886	0.0096	1000.0000	5936

Franking level (%)	100.0000	100.0000	0.0000	100.0000	100.0000	5936
Franking credits per share (cents)	5.8991	2.1429	19.3724	0.0086	1200.0000	5936
Franking credits dividend ratio (%)	42.8571	42.8571	0.0000	42.8571	42.8571	5936
Franking credits yield (%)	1.3406	1.0582	3.3674	0.0383	207.6923	5936
Percentage of individual ownership (%)	45.1497	43.0906	21.7379	0.0273	99.8755	5936
Percentage of international ownership (%)	0.7821	0.3296	2.2479	0.0103	51.5779	5936
50-day cum-dividend period average abnormal adjusted return (%)	0.1312	0.0728	1.5930	-2.2859	84.9535	5922
Ex-dividend date abnormal adjusted return (%)	0.3428	0.0560	3.7241	-31.4609	102.8603	5792
50-day ex-dividend period average abnormal adjusted return (%)	-0.0197	-0.0259	0.3706	-3.7177	10.8117	5931
Panel C: partly franked dividend sample						
Dividend (cents)	21.9908	11.0000	29.9447	0.1000	257.8500	628
Dividend yield (%)	2.7288	2.2039	2.9716	0.1382	58.9744	628
Dividend payout ratio (%)	72.3558	40.6966	116.7087	0.1231	1000.0000	628
Franking level (%)	47.5267	49.4700	23.4284	0.0447	99.3500	628
Franking credits per share (cents)	4.6367	1.6287	7.3994	0.0017	50.8014	628
Franking credits dividend ratio (%)	20.3686	21.2014	10.0407	0.0192	42.5786	628
Franking credits yield (%)	0.5437	0.4412	0.5632	0.0002	8.6766	628
Percentage of individual ownership (%)	35.8629	30.9774	22.8204	0.0486	95.3087	628
Percentage of international ownership (%)	0.9775	0.3648	3.2422	0.0059	44.8016	628
50-day cum-dividend period average abnormal adjusted return (%)	0.1567	0.0253	2.0830	-1.6690	41.6303	625
Ex-dividend date abnormal adjusted return (%)	0.4870	0.1010	3.3994	-13.4985	44.3819	621
50-day ex-dividend period average abnormal adjusted return (%)	-0.0270	-0.0011	0.3022	-2.7135	0.9238	626
Panel D: unfranked dividend sample						
Dividend (cents)	10.5563	4.2500	21.2444	0.0200	325.0000	3135
Dividend yield (%)	4.4655	2.3204	45.2846	0.0232	2366.8421	3135
Dividend payout ratio (%)	61.2688	33.9889	101.4573	0.0012	1000.0000	3135
Franking level (%)	0.0000	0.0000	0.0000	0.0000	0.0000	3135
Franking credits per share (cents)	0.0000	0.0000	0.0000	0.0000	0.0000	3135
Franking credits dividend ratio (%)	0.0000	0.0000	0.0000	0.0000	0.0000	3135

Franking credits yield (%)	0.0000	0.0000	0.0000	0.0000	0.0000	3135
Percentage of individual ownership (%)	45.4389	38.6718	31.3406	0.0486	99.9969	3135
Percentage of international ownership (%)	0.7771	0.2669	3.0787	0.0003	85.2861	3135
50-day cum-dividend period average abnormal adjusted return (%)	0.0924	0.0316	2.3952	-2.9941	132.4200	3122
Ex-dividend date abnormal adjusted return (%)	0.8370	0.2532	5.4462	-10.9342	145.3322	3031
50-day ex-dividend period average abnormal adjusted return (%)	0.0270	-0.0259	2.5552	-2.3776	141.0012	3100

4.5.2 Descriptive graphs

Fig. 4.1 plots the accumulated AAR for fully franked dividends, partly franked dividends, and unfranked dividends terciles during the 100-day window surrounding the ex-dividend date for our sample. It is clear that the accumulated AAR during the cum-dividend period increases faster and reaches a higher point for the fully franked dividends than partly franked and unfranked dividends. This result provides initial visual evidence to support hypotheses 4.1, 4.2, and 4.3 about the ex-dividend period irrational exuberance. Fig. 4.2 plots the accumulated AAR for higher, medium, and lower individual ownership terciles. The figure indicates that firms with a higher or medium level of individual ownership (i.e., lower level of institutional investors) have a higher accumulated AAR before the ex-dividend date but a lower accumulated AAR after the ex-dividend date relative to firms with a lower level of individual ownership. The result provides indirect support for hypothesis 4.4 about the positive relationship between the extent of the ex-dividend period irrational exuberance and individual ownership. Fig. 4.3 is the same as Fig. 4.2 except it divides the sample into terciles by international ownership instead of individual ownership. Fig. 4.3 indicates that firms with a higher international ownership level (i.e., lower domestic ownership level) have higher accumulated AAR prior to the ex-dividend date. However, this finding cannot be used to make inferences about hypothesis 4.5 as the level of international ownership is negligible in the sample, and hence all these plots are of similar magnitude.

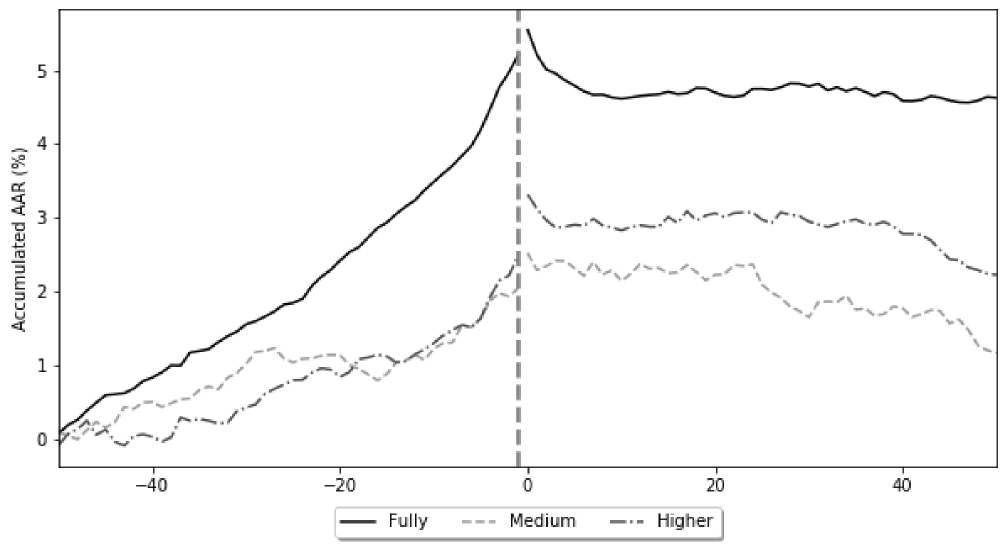

Fig. 4.1. This figure plots the accumulated AAR during the 100-day window surrounding the ex-dividend date for fully franked dividends, partly franked dividends, and unfranked dividends terciles. The sample contains 9699 dividend events between January 1, 2006 and December 31, 2014.

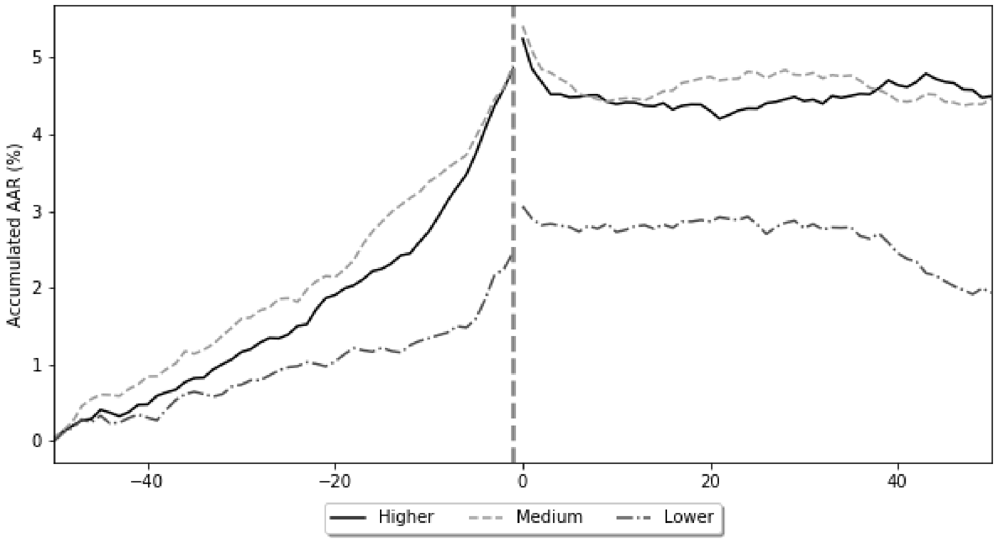

Fig. 4.2. This figure plots the accumulated AAR during the 100-day window surrounding the ex-dividend date for the samples of higher, medium, and lower individual ownership terciles. The sample contains 9699 dividend events between January 1, 2006 and December 31, 2014.

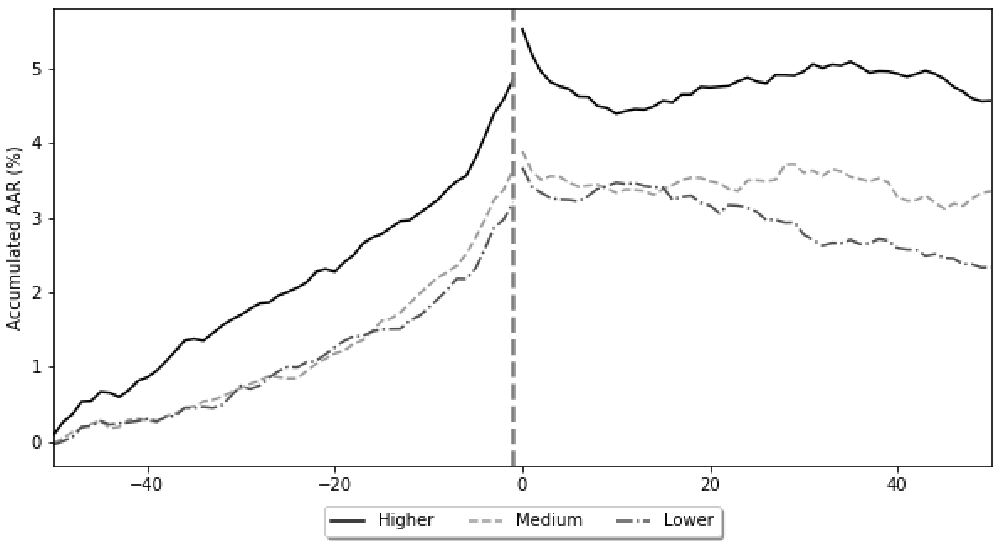

Fig. 4.3. This figure plots the accumulated AAR during the 100-day window surrounding the ex-dividend date for the samples of higher, medium, and lower international ownership terciles. The sample contains 9699 dividend events between January 1, 2006 and December 31, 2014.

4.5.3 Regression results

Table 4.2 reports the OLS regression results of Eq. (4.16). It first validates hypothesis 4.1. The table shows that the intercepts are all positive, and all of them are significant at 10% level for all windows except the 5-day and 10-day windows while the coefficients on EX are all negative and significant at 1% level. The findings confirm the previous literature about the anomaly surrounding the ex-dividend date (Eades et al., 1984; Brown and Clarke, 1993; Bellamy, 2002; Ainsworth et al., 2018) and extends the literature by using a wider window of 50-day to confirm hypothesis 4.1 regarding the existence of the ex-dividend period irrational exuberance. Eq. (4.16) also investigates hypothesis 4.2. The coefficients on dividend payout ratio DPR are positive during the cum-dividend period and negative during the ex-dividend period. It confirms hypothesis 4.2 that the level of the ex-dividend period irrational exuberance is positively correlated to the level of dividends. According to Table E.1 in Appendix E, the sign of coefficients on dividend variables remain the same, but the coefficients become insignificant when the dividend payout ratio is replaced with dividend yield. Eq. (4.16) further examines hypothesis 4.3. Similarly, the coefficients on franking credit dividend ratio FDR during the cum-dividend period and the ex-dividend period are positive and negative, respectively. It verifies hypothesis 4.3 that franking credits are also positively correlated with the ex-dividend period irrational exuberance. The robustness test is also shown in Table E.1 in Appendix E by replacing the franking credit dividend ratio with other franking variables. When franking credits level FL and franked dummy FD are used, the results still hold.

Table 4.3 presents the OLS regression results of Eq. (4.17). The coefficients on the percentage of individual ownership $INDO$ during the cum-dividend period are positive and significant at 1% level from a 5-day window to a 20-day window. The coefficients become negative and significant at 5% level from a 5-day window to a 40-day window during the ex-dividend period. The finding is consistent with hypothesis 4.4 that the level of the ex-dividend period irrational exuberance is positively correlated to the level of individual ownership. Further, the coefficients on the percentage of international ownership $INTO$ are all insignificant. The finding verifies hypothesis 4.5 that international ownership characteristics have no significant statistical impact on the ex-dividend period irrational exuberance. The results are robust to replacing the percentage of individual ownership $INDO$ and the percentage of international ownership $INTO$ with the ownership dummy variables (D_{INDO}/D_{INTO}) in Table E.2 in Appendix E. Overall, the findings are similar.

Table 4.4 shows the results of Eq. (4.18). This model examines the existence of the behavioural finance individual dividend clienteles by examining the impact of individual ownership on the positive relationship between dividends/franking credits and the ex-dividend period irrational exuberance. From this table, most coefficients on DPR/FDR

for both ex-dividend and cum-dividend period are insignificant, indicating that the relationship between dividends/franking credits and the ex-dividend period irrational exuberance addressed in hypothesis 4.4 does not hold for firms with lower individual ownership. After interacting with individual ownership dummy, the coefficients on $D_{INDO} * DPR$ are positive, and $EX * D_{INDO} * DPR$ are negative. The finding indicates the relationship in hypothesis 4.4 holds for firms with higher individual ownership and confirms hypothesis 4.6 that individual ownership strengthens the relationship between dividends and the ex-dividend period irrational exuberance. Similarly, the coefficients on $D_{INDO} * FDR$ changes from positive to negative from 5-day window to 20-day window after the ex-dividend date, indicating that individual ownership also strengthens the relationship between franking credits and the ex-dividend period irrational exuberance. This finding confirms hypothesis 4.7. The test is also robust to replacing dividend variables and franking credits variables. Overall, the findings are similar when the dividend payout ratio is used, but there is no obvious evidence when the dividend yield is used according to Table E.3 in Appendix E.

Table 4.2: OLS model estimates of the ex-dividend period irrational exuberance

This table reports the estimates of coefficients from Eq. (4.16) between January 1, 2006 and December 31, 2014. *EX* takes the value of one when the return is during the ex-dividend period and zero if it is during the cum-dividend period. *DPR* is the dollar amount of dividend per share divided by earnings per share during the previous year. *FDR* is the dollar amount of franking credits per share divided by the dollar amount of dividend per share. $\overline{AAR}$ is the average daily abnormal adjusted return on the ex-dividend date, during the cum-dividend period and the ex-dividend period using 5-day, 10-day, 20-day, 30-day, 40-day and 50-day windows. *LMC* is the log of market capitalisation. *BM* is the ratio of the book value of equity to the market value of a firm's equity. *QSP* is the time-weighted average of limit order bid-ask spread. *IVOL* is the standard deviation of the return based on the mid-point price for each quote update. The regression uses heteroskedasticity-consistent standard error estimator (Davidson and MacKinnon, 1993) and significance at the 10%, 5% and 1% levels is indicated by *, ** and ***, respectively. T-statistics are reported in parentheses.

$\overline{AAR}$	5-day	10-day	20-day	30-day	40-day	50-day
CONST	0.01 (0.95)	0.09 (0.41)	0.12 (0.07)*	0.36 (0.02)**	0.35 (0.01)**	0.32 (0)***
EX	-0.28 (0)***	-0.13 (0)***	-0.10 (0)***	-0.11 (0)*	-0.08 (0)*	-0.08 (0)*
DPR	0.14 (0)***	0.10 (0)***	0.04 (0)***	0.03 (0)***	0.02 (0)**	0.02 (0)**
$EX * DPR$	-0.15 (0)***	-0.13 (0)***	-0.06 (0)***	-0.03 (0)**	-0.03 (0)**	-0.02 (0)**
FDR	0.09 (0.48)	0.19 (0.02)**	0.29 (0.06)*	0.20 (0.08)*	0.27 (0.02)**	0.20 (0)***
$EX * FDR$	-0.16 (0.33)	-0.37 (0)***	-0.38 (0.02)**	-0.28 (0.02)**	-0.34 (0.01)***	-0.19 (0.01)***
LMC	0 (0.7)	0 (0.64)	0 (0.2)	-0.01 (0.02)**	-0.01 (0.01)**	-0.01 (0)***
BM	0.01 (0.51)	0 (0.87)	0 (0.54)	0.01 (0.56)	0.01 (0.33)	0.01 (0.33)
QS	0 (0.23)	0 (0.3)	0 (0.76)	0 (0.26)	0 (0.67)	0 (0.62)
IVOL	27.41 (0.06)*	17.53 (0.07)*	10.18 (0.07)*	6.65 (0.15)	-2.39 (0.59)	-5.13 (0.09)*

Table 4.3: OLS model estimates of effects of ownership holdings on the ex-dividend period irrational exuberance

This table reports the estimates of coefficients from Eq. (4.17) between January 1, 2006 and December 31, 2014. *EX* takes the value of one when the return is during the ex-dividend period and zero if it is during the cum-dividend period. *INDO* is the percentage of individual ownership calculated as the ratio of the number of shares owned by individual investors over the number of shares outstanding. *INTO* is the percentage of international ownership calculated as the ratio of the number of shares owned by international investors over the number of shares outstanding. $\overline{AAR}$ is the average daily abnormal adjusted return on the ex-dividend date, during the cum-dividend period and the ex-dividend period using 5-day, 10-day, 20-day, 30-day, 40-day and 50-day windows. *DY* is the dollar amount of dividend per share, divided by the cum-dividend day closing price. *LMC* is the log of market capitalisation. *BM* is the ratio of the book value of equity to the market value of a firm's equity. *QSP* is the time-weighted average of limit order bid-ask spread. *IVOL* is the standard deviation of the return based on the mid-point price for each quote update. The regression uses heteroskedasticity-consistent standard error estimator (Davidson and MacKinnon, 1993) and significance at the 10%, 5% and 1% levels is indicated by *, ** and ***, respectively. T-statistics are reported in parentheses.

$\overline{AAR}$	5-day	10-day	20-day	30-day	40-day	50-day
CONST	0.19 (0.37)	0.14 (0.27)	0.40 (0.04)**	0.59 (0.01)**	0.61 (0.00)***	0.49 (0.00)***
EX	-0.16 (0.02)**	-0.12 (0.00)***	-0.13 (0.10)	-0.12 (0.09)*	-0.08 (0.16)	-0.10 (0.00)***
INDO	0.30 (0.02)**	0.32 (0.00)***	0.18 (0.00)***	0.09 (0.36)	0.20 (0.19)	0.13 (0.13)
$EX * INDO$	-0.54 (0.00)***	-0.46 (0.00)***	-0.31 (0.00)***	-0.22 (0.01)**	-0.30 (0.05)**	-0.14 (0.12)
INTO	0.49 (0.56)	0.27 (0.68)	-0.71 (0.34)	-0.17 (0.76)	-0.53 (0.37)	-0.05 (0.88)
$EX * INTO$	-2.36 (0.05)**	-0.87 (0.28)	0.33 (0.70)	-0.09 (0.89)	0.37 (0.55)	0.21 (0.59)
DY	-0.32 (0.31)	-0.04 (0.78)	-0.14 (0.17)	-0.08 (0.30)	-0.03 (0.74)	-0.00 (0.96)
LMC	-0.01 (0.51)	-0.00 (0.45)	-0.01 (0.01)***	-0.02 (0.00)***	-0.02 (0.00)***	-0.02 (0.00)***
BM	0.01 (0.53)	0.00 (0.65)	0.01 (0.70)	0.01 (0.46)	0.01 (0.28)	0.01 (0.27)
QSP	-0.01 (0.30)	-0.01 (0.10)*	0.00 (0.41)	-0.00 (0.47)	-0.00 (0.44)	-0.00 (0.23)
IVOL	21.18 (0.25)	10.40 (0.34)	-1.92 (0.79)	-3.65 (0.50)	-9.56 (0.08)*	-10.96 (0.00)***

Table 4.4: OLS model estimates of the behavioural finance dividend clientele

This table reports the estimates of coefficients from Eq. (4.18) between January 1, 2006 and December 31, 2014. EX takes the value of one when the return is during the ex-dividend period and zero if it is during the cum-dividend period. DPR is the dollar amount of dividend per share divided by earnings per share during the previous year. FDR is the dollar amount of franking credits per share divided by the dollar amount of dividend per share. D_{INDO} takes the value of one when $INDO_{j,t}$ is above the higher tercile of $INDO_t$ across all companies in year t and zero when $INDO_{j,t}$ is below the lower tercile. D_{INTO} takes the value of one when $INTO_{j,t}$ is above the higher tercile of $INTO_t$ across all companies in year t and zero when $INTO_{j,t}$ is below the lower tercile. $\overline{AAR}$ is the average daily abnormal adjusted return on the ex-dividend date, during the cum-dividend period and the ex-dividend period using 5-day, 10-day, 20-day, 30-day, 40-day and 50-day windows. LMC is the log of market capitalisation. BM is the ratio of the book value of equity to the market value of a firm's equity. QSP is the time-weighted average of limit order bid-ask spread. $IVOL$ is the standard deviation of the return based on the mid-point price for each quote update. The regression uses heteroskedasticity-consistent standard error estimator (Davidson and MacKinnon, 1993) and significance at the 10%, 5% and 1% levels is indicated by *, ** and ***, respectively. T-statistics are reported in parentheses.

$\overline{AAR}$	5-day	10-day	20-day	30-day	40-day	50-day
$CONST$	1.22(0.07)*	0.92(0.01)**	0.51(0.08)*	0.46(0.04)**	0.43(0.01)**	0.36(0.01)***
EX	-0.23(0.15)	-0.04(0.76)	-0.01(0.90)	-0.01(0.84)	-0.00(0.94)	-0.04(0.17)
DPR	0.05(0.55)	0.02(0.72)	0.03(0.27)	0.02(0.35)	0.02(0.24)	0.02(0.04)**
$EX*DPR$	-0.17(0.19)	-0.12(0.28)	-0.07(0.32)	-0.04(0.27)	-0.03(0.44)	-0.02(0.45)
FDR	-0.59(0.11)	-0.15(0.52)	-0.09(0.50)	-0.03(0.76)	0.07(0.45)	0.07(0.24)
$EX*FDR$	0.95(0.04)**	0.02(0.95)	0.01(0.95)	-0.10(0.48)	-0.21(0.08)*	-0.09(0.31)
D_{INDO}	-0.55(0.09)*	-0.36(0.07)*	-0.04(0.71)	0.03(0.75)	0.01(0.88)	0.04(0.47)
$Ex*D_{INDO}$	0.39(0.32)	0.31(0.19)	0.04(0.75)	-0.11(0.34)	-0.03(0.80)	0.00(0.97)
D_{INTO}	0.08 (0.49)	0.05 (0.50)	0.05 (0.29)	0.02 (0.67)	0.02 (0.53)	0.03 (0.21)
$Ex*D_{INTO}$	-0.19 (0.22)	-0.19 (0.05)**	-0.11 (0.08)*	-0.04 (0.47)	-0.03 (0.47)	-0.05 (0.10)
$D_{INDO}*DPR$	0.39(0.12)	0.31(0.04)**	0.10(0.07)*	0.09(0.12)	0.08(0.09)*	0.05(0.11)
$Ex*D_{INDO}*DPR$	-0.25(0.37)	-0.27(0.14)	-0.12(0.20)	-0.09(0.17)	-0.12(0.05)**	-0.09(0.03)**
$D_{INDO}*FDR$	1.82(0.02)**	0.96(0.04)**	0.42(0.15)	0.16(0.50)	0.10(0.62)	-0.01(0.94)
$Ex*D_{INDO}*FDR$	-2.35(0.01)**	-1.14(0.05)**	-0.64(0.08)*	-0.12(0.69)	-0.10(0.72)	-0.04(0.83)
LMC	-0.05 (0.05)*	-0.04 (0.03)**	-0.02 (0.06)*	-0.02 (0.04)**	-0.02 (0.01)***	-0.02 (0.00)***
BM	-0.02 (0.20)	-0.01 (0.68)	0.00 (0.98)	0.01 (0.50)	0.01 (0.20)	0.01 (0.18)
QSP	-0.02 (0.15)	-0.01 (0.33)	0.01 (0.41)	0.01 (0.57)	0.01 (0.18)	0.00 (0.38)
$IVOL$	47.63 (0.26)	-5.54 (0.48)	-5.29 (0.62)	-6.06 (0.52)	-8.86 (0.31)	-10.53 (0.15)

4.6 Conclusion and original contribution

Empirically, this chapter investigates the effects of franking credits on the ex-dividend period irrational exuberance and dividend clienteles for all dividend-paying securities listed on ASX during the period between 2006 and 2014. This chapter first validates the existence of ex-dividend period irrational exuberance (a price run-up before the ex-dividend date and price run-down after the ex-dividend date) by examining the movement of the abnormal adjusted return surrounding the ex-dividend date. It extends the existing literature (Eades et al., 1984; Brown and Clarke, 1993; Bellamy, 2002; Ainsworth et al., 2018) by applying a wider range of examining window (5-day, 10-day, 20-day, 30-day, 40-day, 50-day) surrounding the ex-dividend date. In addition, this chapter finds a positive relationship between the level of dividends/franking credits and the ex-dividend period irrational exuberance.

This chapter then verifies the existence of the individual dividend clienteles in two steps. This chapter relates the ex-dividend period irrational exuberance with the firm's ownership characteristics and finds that individual investors are the net buyers before the ex-dividend date and net sellers after the ex-dividend date while institutional investors are their counterparties. There is no direct evidence to show a significant impact of international investors on the ex-dividend period irrational exuberance. Further, this chapter finds that an increase in the percentage of individual investors holdings strengthens the positive relationship between dividends/franking credits and the ex-dividend period irrational exuberance. The results contradict Jun et al.'s (2006) finding but are consistent with Ainsworth et al.'s (2016a) finding that the evidence of tax-induced explanation dividend clienteles is limited in Australia.

Theoretically, this chapter proposes behavioural finance explanations of dividend clienteles to explain the relationship among individual ownership, dividends/franking credits, and the ex-dividend period irrational exuberance. The theory states that individual investors prefer dividends and franking credits to capital gains due to the "bird in the hand" fallacy that individual investors are more likely to be attracted by more stable income (Gordon, 1963; Lintner, 1964; Dennis and Strickland, 2002; Barber and Odean, 2013), the "behavioural life-cycle" theory that dividends and franking credits are preferred by certain groups of investors (specifically, retirees) whose source of income depends heavily on dividends (Shefrin and Statman, 1984; Dong et al., 2005), and the "information signaling" theory that individual investors are inclined to be impacted by the signaling role of dividends as their information sources are limited (Bhattacharya, 1979).

As discussed in Section 2.4.1.4, one main limitation of the ex-dividend date studies is that the estimate of the franking credits from the drop-off ratio is driven more by short-term investors rather than a firm's marginal investors (Cannavan et al., 2004; Siau et al., 2015; Miller and Scholes, 1982; Poterba, 1986; McDonald, 2001). This chapter addresses this limitation by investigating the influence of franking credits in a longer window instead of only on the ex-dividend date.

In summary, this chapter proposes a behavioural finance explanation of dividend clientele that individual investors purchase shares before the ex-dividend date and sell them after the ex-dividend date as their preference for dividends/franking credits exists for multiple reasons (i.e., the "bird in the hand" fallacy, the "behavioural life-cycle" theory, and the "information signaling" theory), thus contributing to the ex-dividend period irrational exuberance. This chapter contributes to the debate by providing evidence that franking credits are priced in the Australian equity market.

Chapter 5

The Valuation and Determinants of Franking Account Balances

5.1 Introduction

As discussed in Section 2.4.4, although the debate on whether franking credits are priced in the Australian market has attracted much attention, the literature on whether undistributed franking credits (franking credit balances) are priced is scarce to date. Corporate tax-paying entities keep an account called a "franking account". The franking credits account records the amount of undistributed franking credit at each year end. The franking credit balances accumulate when the corporate entity receives franking credits or pays corporate taxes. In contrast, the franking credit balances decrease when the corporate entity distributes franking credits or receives a tax refund (Australian Taxation Office, 2020e). Although companies that distribute more franking credits than their franking credit balances will receive a penalty as described in rule 5 in Section 2.2.4, they can choose not to distribute all available franking credits through partly franked or unfranked dividends, thus accumulating their franking credit balances.

Theoretically, companies should distribute all available franking credits because the valuation of franking credits reduces the longer they remain undistributed. However, the significant build-up of franking credit balances for Australian companies becomes a puzzle in the existing literature. What are the determinants contributing to the level of franking credit balances? Heaney (2009) proposes a size effect and an international focus effect such that large firms with higher international ownership tend to build up their franking credit balances. He finds evidence of the size effect. However, he is unable to find evidence to confirm the international focus effect due to the difficulty of identifying ownership constituents. This chapter extends Heaney's (2009) work by replacing the ratio of non-resident revenue to total revenue (the proxy that used by Heaney (2009)) with the percentage of international ownership as a direct measure of international focus, thus addressing the limitation of his measure. The fixed effects panel data analysis provides strong evidence of the size effect and weak evidence of the international focus effect.

The international focus effect is based on the fact that international investors are not eligible for franking credits, and firms would choose their dividend policy depending on their ownership structure if the marginal investors can influence firms' dividend policy. The extant literature usually separates investors into two main groups (resident investors and international investors) depending on their eligibility for franking credits. However, the literature ignores the fact that different investor communities might value franking credits differently for many reasons (e.g., individual dividend clientele) even though they are all eligible for franking credits. Accordingly, this chapter relates the determinants of franking balances with the individual dividend clientele addressed in ex-dividend studies documented in Chapter 4. This gives rise to the individual dividend clientele effect that firms choose to reduce their franking credit balances when the firms are held by more individual investors with irrational preference to franking credits. This chapter provides strong evidence of the individual dividend clientele effect.

Are franking credit balances priced in the market? This chapter further conducts value relevance studies to explore this question. The foundation of these studies is Monkhouse's (1993) theoretical framework that if franking credits are priced in the market, franking credit balances that represent the ability of future distribution of franking credits should also be reflected in the share price. Monkhouse (1993) derives a CAPM, which assumes that franking credit balances are priced in the market, and the market valuation of franking credit balances is equal for all companies in the context of the Australian imputation system. Heaney (2009) conducts the first empirical value relevance test to examine the market valuation of franking credits. He uses a sample of firms that report franking credit balances in their annual report on ASX between 2001 and 2006. He applies the fixed effects panel analysis and finds that franking credit balances are of value to marginal investors in small companies, but there is no evidence of value in large companies. Following his research, Tanza (2014) combines Heaney (2009) and Ohlson's (1995) research by incorporating franking credit balances in the residual income model and finds that one dollar of franking credit balances is worth 1.34 dollars in the market using a sample of securities in ASX 100 from 1996 to 2013. This chapter extends Tanza's (2014) model by expanding the sample period and sample constituents and by applying a log-transformation to reduce the skewness of the sample. Additionally, earnings or future earnings are used alternately in the model to deal with the multicollinearity between the independent variables in the model. The fixed effects panel data regression examines the market valuation of franking credit balances by measuring the sensitivity of the logarithm of market capitalisation to the logarithm of franking credit balances. There is evidence that franking credit balances are priced in the market using the sample of securities in ASX 200 from 2000 to 2018. Each dollar of franking credit balances is found to the valued at approximately \$1.4. Accordingly, this result is consistent with Tanza's (2014) findings of \$1.34.

This chapter further relates the market valuation of franking credit balances with firm size and international focus. Heaney (2009) provides evidence that franking credit balances are priced in small companies but not in large companies, indicating a negative relationship between firm size and the market valuation of franking credit balances. He proposes that large companies attract more international investors who are not eligible for franking credits, thus leading to lower valuation of franking credit balances. This chapter first examines the relationship between firm size and the market valuation of franking credits by adding market capitalisation dummies in the value relevance models. The analysis initially finds results that investors in large firms place a **higher** valuation on franking credit balances. Due to the lack of ownership data, Heaney (2009) could not test this proposition. This chapter then verifies Heaney's (2009) proposition by splitting the proposition into two partitions. Firstly, large firms attract more international investors. Secondly, international investors place a lower valuation of firms with higher franking credit balances. This chapter tests both sub-propositions. The Pearson correlation test verifies the first sub-proposition, and shows that firm size is negatively correlated with the percentage of international ownership holdings[1]. This chapter then examines the second sub-proposition by adding international ownership dummies in the value relevance models and finds evidence to support this sub-proposition. Overall, the findings are consistent with the second sub-proposition but inconsistent with the first sub-proposition. In particular, the evidence shows that large firms have a higher percentage of domestic resident ownership who place a higher valuation on franking credit balances. The market valuation of franking credit balances is positively correlated with firm size but negatively correlated with international focus.

The reminder of this chapter is organized as follows. Section 5.2 reviews the literature on the determinants and valuation of franking credit balances. Sections 5.3 and 5.4 describe data collection and methodology. Section 5.5 reports the empirical results. Section 5.6 concludes this chapter.

5.2 Literature review

As mentioned in Section 2.4.4, although the contention as to whether franking credits are priced is topical, there is little attention directed to the market valuation of franking credit balances in Australia. Section 5.2.1 illustrates the theoretical literature. Section 5.2.2

[1]This is due to the use of the percentage of international ownership as the proxy for the international holdings. If the number of shares held by international investors is used, the relationship between firm size and international holdings becomes positive. Although large firms attract more international investors in terms of the number of shares holdings, the percentage of international ownership does not increase as the more significant increase in the total number of shares outstanding.

reviews the empirical literature.

5.2.1 Theoretical literature

Monkhouse (1993) develops the theoretical framework of franking credit balances studies by deriving a CAPM that incorporates both distributed franking credits and undistributed franking credits as shown below:

$$E(R_{jt}) = r_{ft} + \beta_j[E(R_{mt}) - r_{ft}] - \theta_j^d D_j F_{jt} - \theta_m^r RIC_j, \tag{5.1}$$

where $E(R_{jt})$ is the expected return for security j at time t, r_{ft} is the risk-free rate, $E(R_{mt})$ is the expected return on the market portfolio, θ_j^d is the utilisation factor of distributed franking credits for security j, D_j is the gross dividend distributed by security j, F_{jt} is the franking credit rate of security j, θ_m^r is the utilisation factor of franking credit balances for the entire market, and RIC_j is the level of undistributed franking credits retained by security j.

According to Monkhouse's (1993) CAPM model, both distributed and undistributed franking credits reduce the required rate of returns of firms with a utilisation ratio of θ_j^d and θ_m^r respectively. One fundamental assumption in his model is that the utilisation of franking credit balance (θ_m^r) is equal for all firms. He comments that these parameters cannot be measured theoretically but have to be estimated empirically.

5.2.2 Empirical literature

5.2.2.1 Determinants of level of franking credit balances

The first stream of empirical literature analyses the determinants of franking credit balances. In an efficient market that is frictionless, information is costless and simultaneously available, and companies are expected to distribute all available franking credits to attract investors because the market valuation of undistributed franking credit is expected to be less than that of distributed franking credits due to time value of money (Nigol, 1992; Monkhouse, 1993). However, franking credit balances accumulate over time where distributed dividends do not attach all available franking credits in Australia after 1987[2] due to many factors (Wood, 1997). Heaney (2009) proposes the size effect and the international focus effect that the level of franking credit balances is positively related to firm size and international holdings. Heaney (2009) and Tanza (2014) find consistent evidence for the size effect. If franking credit balances are valuable to shareholders, it is expected that firms will choose to manipulate the level of franking credits attached with dividends depending on whether their marginal investors can benefit from franking credits. If the

[2]The sum of franking credit balances of all Australian companies was estimated to be $100 billion in 2010 (Kerin, 2010).

firm's marginal investors are resident investors, the firm is more likely to distribute more franking credits, thus reducing the level of its franking credit balances. However, if the firm's marginal investors are international investors, the firm tends to avoid distributing franking credits, thus building up its franking credit balances. However, Heaney (2009) cannot verify the international focus effect due to the difficulty of identifying the ownership characteristics of firms. Abraham (2013) and Tanza (2014) extend Heaney's (2009) work by using international ownership as the proxy for the international focus and find evidence to support the international focus effect. The size effect and the international focus effect are stated in the following two hypotheses.

Hypothesis 5.1: *The level of franking credit balances is positively correlated with the size of the firm.*

Hypothesis 5.2: *The level of franking credit balances is positively correlated with the percentage of international ownership of the firm.*

According to Section 2.2.3, this chapter recognises four classes of investors according to their tax brackets under the current tax regulations in Australia. The first three communities are Australian tax-paying residents, Australian superannuation funds, and Australian tax-exempt residents who are eligible for franking credits after the introduction of tax rebate in July 2000 described in rule 4 in Section 2.2.5. The last investment community is international shareholders who are not eligible for franking credits. The existing literature mainly divides the investors into two classes, resident investors and international investors, depending on their eligibility to receive franking credits (Wood, 1997). However, the tax differences among the first three communities are ignored in the extant literature. According to the findings of individual dividend clienteles evidenced in Chapter 4 and other ex-dividend studies literature (Ainsworth et al., 2016a), individual investors irrationally place a higher valuation on dividends and franking credits than capital gains compared with institutional investors. Does the individual dividend clientele impact firms' decision to distribute franking credits? This chapter proposes the individual dividend clientele effect hypothesis that companies would choose to distribute more franking credits if the marginal investors are individual investors who prefer franking credits to optimise the absorption of franking credits. This gives rise to the third hypothesis:

Hypothesis 5.3: *The level of franking credit balances is negatively correlated with the percentage of individual ownership of the firm.*

5.2.2.2 Market valuation of franking credit balances

Are franking credit balances priced in the market? The second stream of empirical literature examines the market valuation (utilisation ratio θ_m^r introduced in Section 5.2.1) of franking credit balances. The accumulation of franking credit balances for Australian companies after 1987 provides researchers with a platform to conduct empirical franking credit balances studies. Following Monkhouse's (1993) theoretical work, Heaney (2009) conducts the first empirical franking credit balances value relevance study. In particular, Heaney (2009) implements the fixed effects analysis to examine the sensitivity of the level of market capitalisation to the level of franking credit balances based on over 3000 yearly observations of firms listed on ASX from 2001 to 2006. The findings suggest that the level of franking credit balances is uncorrelated with the firms' market capitalisation using the sample of the 100 largest listed companies. Tanza (2014) attempts to replicate Heaney's (2009) findings by incorporating franking credit balances as the independent variable in the residual income model (Ohlson, 1995). In contrast with Heaney's (2009) findings, his findings suggest that one dollar of franking credit balances is worth 1.34 dollars of market capitalisation using the sample of securities in ASX 100. However, there are two limitations, named multicollinearity and skewness, in Tanza's (2014) value relevance model described in Section 5.4. To reconcile the conflicting results, this chapter extends Tanza's (2014) value relevance model by addressing the limitations to verify the value relevance hypothesis using a more recent period and an expanded sample of firms.

Hypothesis 5.4: *The market capitalisation of firms is positively correlated with the level of franking credit balances.*

Although Heaney (2009) does not find a positive market valuation of franking credit balances using the sample of large companies, he finds a positive valuation of franking credit balances in the full sample and relatively small companies that do not fall within the largest 100. It indicates a negative relationship between firm size and the market valuation of franking credit balances. This chapter examines Heaney's (2009) findings by relating the market valuation of franking credit balances (the relationship between market capitalisation and franking credit balances) with firm size.

Hypothesis 5.5: *The market valuation of franking credit balances is negatively correlated with firm size.*

Heaney (2009) argues that this inconsistent result depending on firm size can be explained by the proposition that the marginal shareholders of large companies are foreign investors who do not value franking credits, whereas the marginal investors of smaller companies are Australian resident investors. His proposition consists of two parts. Firstly, firm size is positively correlated with international ownership. The evidence of international investors' preference in large and international companies has been found in Taiwan and Sweden (Dahlquist and Robertsson, 2001; Lin and Shiu, 2003). Heaney (2009) argues that it is intuitive to apply the relationship in Australia. Secondly, the market value of franking credit balances documented in hypothesis 5.4 should be negatively correlated with the percentage of international investors. Due to the lack of ownership holdings data, Heaney (2009) cannot verify this explanation. This chapter tests this proposition through the following two hypotheses using unique ownership constituent data.

Hypothesis 5.6: *The size of firms is positively correlated with the international ownership holdings.*

Hypothesis 5.7: *The market valuation of franking credit balances is negatively correlated with the international ownership holdings.*

5.3 Data collection

The initial data set contains the constituents of the S&P/ASX 200 index over the period 1 January 2001 through to 31 December 2018. The constituents of ASX 200 are derived from Bloomberg. Franking credit balances of each company are collected from Bloomberg with gaps filled manually from the notes in annual reports from DatAnalysis Premium, Connect4 databases, and company websites. Accounting data including total assets, total liabilities, total revenue, net income, research and development expenditure, the ratio of foreign income to net income, and the market capitalisation are collected from Thomson Reuters Datastream database. To replace the proxy of international focus in Heaney's (2009) paper, ownership data are collected. The number of shares held by individual investors, institutional investors, Australian resident investors, international investors, and the total number of shares outstanding on a daily basis are obtained from the ASX's CHESS database. The detailed information of the CHESS database is described in Section 4.3.

5.4 Methodology

This chapter applies fixed-time effects and fixed-company effects multivariate panel OLS regressions to examine the hypotheses described above in Section 5.2.2.

5.4.1 Determinants of level of franking credit balances

This chapter extends Heaney (2009) and Tanza's (2014) model to analyse the determinants of franking credit balances through an examination of the size effect, the international focus effect, and the individual dividend clientele effect. To verify these three effects in hypotheses 5.1, 5.2, and 5.3, respectively, the tests using the fixed-time and fixed-company effects panel data regression as follows:

$$\begin{aligned}LFB_{jt} =&\beta_{j,0}+\beta_{t,0}+\beta_1 LBVA_{j,t}+\beta_2 INTO_{j,t}+\beta_3 INDO_{j,t}+\beta_4 PROF_{j,t}+\beta_5 LEV_{j,t}\\&+\beta_6 GO_{j,t}+\varepsilon_{j,t},\end{aligned} \tag{5.2}$$

where $LFB_{j,t}$ is the natural logarithm of franking credit balances of company j at time t, $LBVA_{j,t}$ is the natural logarithm of book value of assets of company j at time t to proxy for firm size, $INTO_{j,t}$ is the percentage of international ownership of company j at time t to proxy for international focus, $INDO_{j,t}$ is the percentage of individual ownership of company j at time t, $PROF_{j,t}$ is profitability (net profit after tax to total revenue) of company j at time t, $LEV_{j,t}$ is leverage (total liabilities to book value of assets) of company j at time t, $GO_{j,t}$ is growth option (research and development (R&D) expenditure to total revenue) of company j at time t.

According to the size effect, the international focus effect, and the individual dividend clientele effect described in hypotheses 5.1, 5.2 and 5.3, β_1, β_2 are expected to be positive and β_3 is expected to be negative.

5.4.2 Market valuation of franking credit balances

If franking credit balances are priced in the market, the level of franking credit balances should be positively correlated with firm value. This chapter follows Heaney (2009) and Tanza's (2014) work to examine the market valuation of franking credits. Tanza (2014) applies a panel regression based on Ohlson's (1995) residual income model to measure the sensitivity of the market value of the firm to the level of franking credit balances, which is shown as below.

$$MC_{jt} = \alpha_{j,0}+\alpha_{t,0}+\beta_1 FB_{j,t}+\beta_2 NTA_{j,t}+\beta_3 EARN_{j,t}+\beta_4 EARN_{j,t+1}+\varepsilon_{j,t}, \tag{5.3}$$

where MC_{jt} is the market capitalisation of company j at time t, $FB_{j,t}$ is franking credit balances of company j at time t, $NTA_{j,t}$ is net assets of company j at time t, $EARN_{j,t}$ is earnings of company j at time t, and $EARN_{j,t+1}$ is future earnings of company j at time $t+1$.

Ohlson's (1995) residual income model states that the market value of firm depdends on the book value of firm and the future residual income. In Tanza's (2014) value relevance model, $NTA_{j,t}$ is used to proxy for the book value of firm, and $EARN_{j,t}$ and $EARN_{j,t+1}$ are used to proxy for the future residual income. One limitation of Tanza's (2014) model is that market capitalisation, and franking credit balances are extremely right-skewed according to Fig. 5.3 and Fig. 5.1. The highly skewed dependent and independent variables make the OLS regression inappropriate as the OLS regression model estimates the mean, while the mean is not an appropriate proxy of central tendency in a skewed distribution. This chapter improves Tanza's (2014) model by applying a log-transformation. After the log-transformation, variables become less skewed and more normally distributed. Another limitation of Tanza's (2014) model is the multicollinearity between $EARN_{j,t}$ and $EARN_{j,t+1}$ shown in Table 5.2. This chapter improves Tanza's (2014) model by avoiding using both $LEARN_{j,t}$ and $LEARN_{j,t+1}$ in one model. Alternately, Eq. (5.4) uses $LEARN_{j,t}$ or $LEARN_{j,t+1}$ exclusively as the proxy for future earnings. The log-transformation model is shown as below:

$$LMC_{jt} = \alpha_{j,0} + \alpha_{t,0} + \beta_1 LFB_{j,t} + \beta_2 LNTA_{j,t} + \beta_3 LEARN_{j,t} \ or \ LEARN_{j,t+1} + \varepsilon_{j,t}, \quad (5.4)$$

where LMC_{jt} is the natural logarithm of market capitalisation of company j at time t, $LFB_{j,t}$ is the natural logarithm of franking credit balances of company j at time t, $LNTA_{j,t}$ is the natural logarithm of net assets of company j at time t, $LEARN_{j,t}$ is the natural logarithm of earnings of company j at time t, and $LEARN_{j,t+1}$ is the natural logarithm of future earnings of company j at time $t+1$.

Eq. (5.5) further extends Eq. (5.4) by adding interaction terms between market capitalisation dummies and franking credit balances to verify Heaney's (2009) findings of a negative relationship between firm size and the market valuation of franking credit balances documented in hypothesis 5.5. The market capitalisation dummies are constructed for each year so as to avoid foresight bias. For example, $D2_{MC_{j,t}}$ is equal to one when the market capitalisation for the company j at time t is above the median of market capitalisation across all companies at time t and zero otherwise.

$$\begin{aligned} LMC_{jt} = & \alpha_{j,0} + \alpha_{t,0} + \beta_1 LFB_{j,t} + \beta_2 D1_{MC_{j,t}} * LFB_{j,t} + \beta_3 D2_{MC_{j,t}} * LFB_{j,t} \\ & + \beta_4 D3_{MC_{j,t}} * LFB_{j,t} + \beta_5 LNTA_{j,t} + \beta_6 LEARN_{j,t} \ or \ LEARN_{j,t+1} + \varepsilon_{j,t}, \end{aligned} \quad (5.5)$$

where $D1_{MC_{j,t}}$ takes the value of one when $MC_{j,t}$ is above the lower (25%) quartile of MC_t across all companies in year t and zero otherwise, $D2_{MC_{j,t}}$ takes the value of one when $MC_{j,t}$ is above the median of MC_t across all companies in year t and zero otherwise, and $D3_{MC_{j,t}}$ takes the value of one when $MC_{j,t}$ is above the upper (75%) quartile of MC_t across all companies in year t and zero otherwise.

Heaney (2009) raises the proposition that the marginal investors of large firms are more likely to be international investors who tend to place less value on franking credits to explain his findings. To verify this proposition, this chapter first verifies hypothesis 5.6 by examining the correlation between size and the percentage of international ownership.

This chapter further examines hypothesis 5.7 by using Eq. (5.6), which incorporates interaction terms between international ownership percentage dummy and franking credit balances. Similar to $D2_{MC_{j,t}}$, $D2_{INTO_{j,t}}$ is equal to one when the percentage of international ownership for the company j in year t is above the median of the percentage of international ownership across all companies in year t and zero otherwise.

$$\begin{aligned} LMC_{jt} = &\alpha_{j,0} + \alpha_{t,0} + \beta_1 LFB_{j,t} + \beta_2 D1_{INTO_{j,t}} * LFB_{j,t} + \beta_3 D2_{INTO_{j,t}} * LFB_{j,t} \\ &+ \beta_4 D3_{INTO_{j,t}} * LFB_{j,t} + \beta_5 LNTA_{j,t} + \beta_6 LEARN_{j,t} \ or \ LEARN_{j,t+1} + \varepsilon_{j,t}, \end{aligned} \tag{5.6}$$

where $D1_{INTO_{j,t}}$ takes the value of one when $INTO_{j,t}$ is above the lower (25%) quartile of $INTO_t$ across all companies in year t and zero otherwise, $D2_{INTO_{j,t}}$ takes the value of one when $INTO_{j,t}$ is above the median of $INTO_t$ across all companies in year t and zero otherwise, $D3_{INTO_{j,t}}$ takes the value of one when $INTO_{j,t}$ is above the upper (75%) quartile of $INTO_t$ across all companies in year t and zero otherwise.

5.5 Empirical results

5.5.1 Summary statistics

Table 5.1 reports summary statistics for all companies in ASX 200 from 2000 to 2018. The magnitudes and dispersions of the variables are examined. This table shows that the average of franking credit balances (dollars in millions) is 212.9061, with a median of 27.8480 through the sample period. The mean is much greater than the median, showing that the distribution is right-skewed. Fig. 5.1 confirms that the distribution of franking credit balances is highly right-skewed with skewness of 11.38. Similar to franking credit balances, the distribution of market capitalisation is also right-skewed with a mean of 7379.3916 that is much greater than the median of 1740.0035. Fig. 5.3 shows a right-skewness of 5.95. In short, franking credit balances and market capitalisation are not normally distributed. The mean and median of franking credit balances after applying log-transformation are 3.3852 and 3.3803, respectively. Similarly, the logarithm of market capitalisation averages 7.4143 with a medium of 7.4616. Fig. 5.2 and Fig. 5.4 indicate that the skewness of franking credit balances and the market capitalisation after applying log-transformation reduce to -0.4127 and -0.4953 respectively. Overall, the closer mean and median of variables and the reducing skewness suggest that these two variables follow a lognormal distribution. The log-transformation improves the reliability of panel data OLS regression.

The average of the logarithm of total assets of firms as the proxy of firm size is 7.3758. For ownership data, the percentage of international ownership has an average at 0.48%, with a standard deviation of 0.28%. The percentage of individual ownership is much higher, with a mean of 34.94% and a standard deviation of 30.68%. For control variables in the determinant analysis, the profitability, leverage, and growth options across all firms are 2.7070, 0.5084, and 0.0075. Control variables in value relevance tests are the logarithm of net assets with a mean and a standard deviation of 6.5815 and 1.9903, the logarithm of earnings with a mean and a standard deviation of 4.7034 and 1.8249, and the logarithm of future earnings with a mean and a standard deviation of 4.7988 and 1.7849.

5.5.2 Pearson correlation matrix

The Pearson correlation matrix results shown in Table 5.2 indicate that many variables are marginally correlated with statistical significance of 1% and 5%. For example, the logarithm of franking credits balances is positively correlated with the logarithm of the book value of total assets but negatively correlated with the percentage of international ownership. This provides initial evidence consistent with hypotheses 5.1 but contradicts hypothesis 5.2. The correlation between the logarithm of market capitalisation and the logarithm of franking credit balances is positive and significant, which is as expected as per hypothesis 5.4. For hypothesis 5.6, the logarithm of market capitalisation is negatively correlated with the percentage of international ownership holdings at 1% significance level, which contradicts Heaney's (2009) proposition that large firms attract more international investors documented in Taiwan (Dahlquist and Robertsson, 2001) and Sweden (Lin and Shiu, 2003). The contradictory findings are due to the use of the percentage of international ownership holdings rather than the number of shares held of international ownership as the proxy for international focus[3]. $LEARN_t$ and $LEARN_{t+1}$ are highly correlated as expected, which might cause the multicollinearity in Tanza's (2014) value relevance model as discussed in Section 5.4.2.

[3]The correlation between the logarithm of market capitalisation and the number of shares held by international investors is 0.3667 with significance at 1%. This is consistent with Heaney's (2009) proposition. However, using the number of shares held by international investors as the proxy for international focus does not consider the changes in the total number of shares outstanding. Therefore, the percentage of international ownership is a better proxy.

Table 5.1: Summary statistics

This table reports the mean, median, standard deviation, minimum, maximum, and the number of observations for ASX 200 firms between 2000 and 2018. *FB* is the dollar value of franking credit balances in millions. *LFB* is the natural logarithm of franking credit balances. *LBVA* is the natural logarithm of the book value of assets. *INTO* is the percentage of international ownership calculated as the ratio of the number of shares owned by international investors over the number of shares outstanding. *INDO* is the percentage of individual ownership calculated as the ratio of the number of shares owned by individual investors over the number of shares outstanding. *PROF* is calculated as net profit after tax to total revenue as the proxy for profitability. *LEV* is calculated as total liabilities to book value of assets as the proxy for leverage. *GO* is calculated as Research and development (R&D) expenditure to total revenue as the proxy for growth options. *MC* is the market capitalisation. *LMC* is the natural logarithm of market capitalisation. *LNTA* is the natural logarithm of net assets. $LEARN_t$ is the natural logarithm of earnings. $LEARN_{t+1}$ is the natural logarithm of future earnings.

Variable	Mean	Median	Std.	Min.	Max.	N.
FB	212.9061	27.8480	997.5150	-51.6000	18290.0000	1838
LFB	3.3852	3.3803	2.0898	-4.7105	9.8141	1799
LBVA	7.3758	7.4942	2.2805	-3.5405	13.7906	2680
INTO	0.0048	0.0028	0.0171	0.0000	0.5959	1998
INDO	0.3494	0.3068	0.2156	0.0038	0.9852	2168
PROF	2.7070	0.0964	113.1710	-496.3333	4234.0690	2670
LEV	0.5084	0.4794	0.3915	-0.3519	10.4344	2680
GO	0.0075	0.0000	0.0343	0.0000	0.7240	2903
MC	7397.3916	1740.0035	19945.0761	0.9900	243187.1000	2538
LMC	7.4143	7.4616	1.8514	-0.0101	12.4016	2538
LNAT	6.5815	6.7629	1.9903	-3.8167	11.4241	2646
$LEARN_t$	4.7034	4.6778	1.8249	-5.1160	10.0811	2251
$LEARN_{t+1}$	4.7988	4.7637	1.7849	-5.1160	10.0811	2278

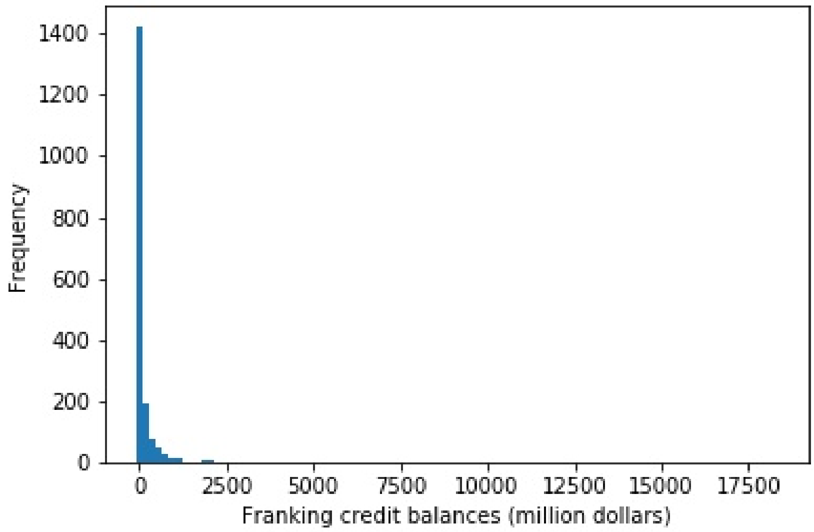

Fig. 5.1. The figure plots the histogram of franking credit balances in million dollars for firms in ASX 200 from 2000 to 2018. The skewness of franking credit balances is 11.38.

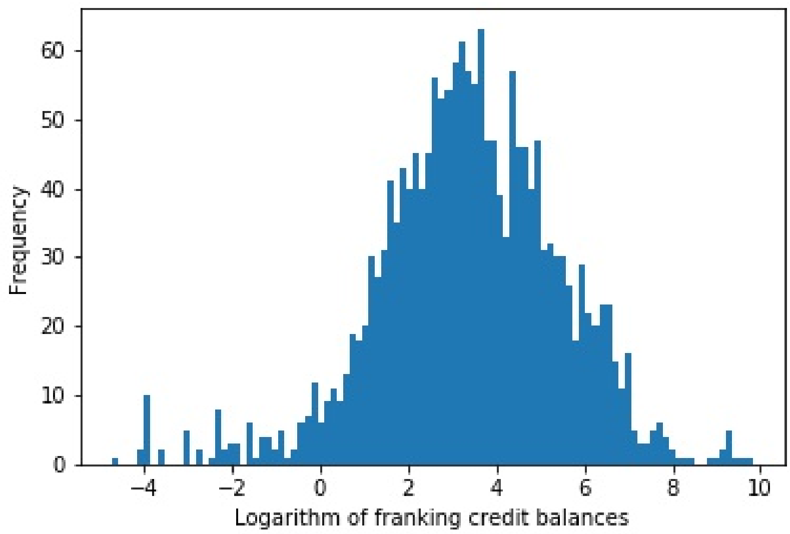

Fig. 5.2. The figure plots the histogram of the logarithm of franking credit balances in million dollars for firms in ASX 200 from 2000 to 2018. The skewness of the logarithm of market capitalisation is -0.4127.

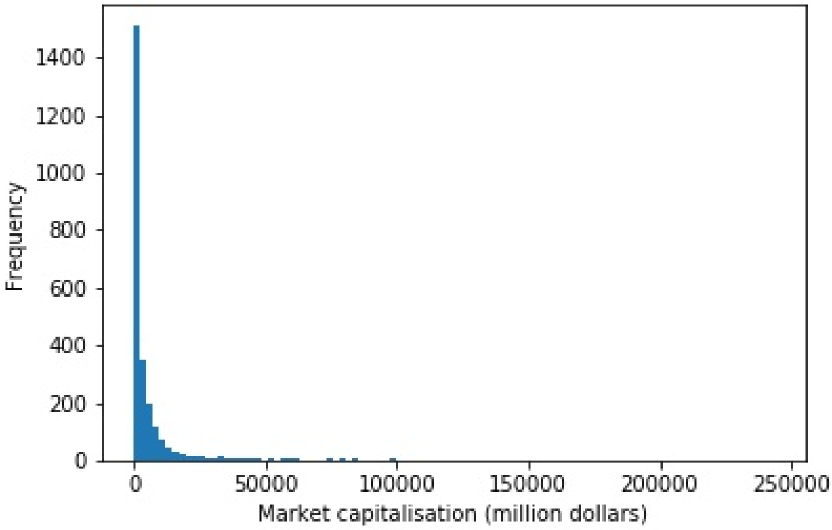

Fig. 5.3. The figure plots the histogram of market capitalisation in million dollars for firms in ASX 200 from 2000 to 2018. The skewness of market capitalisation is 5.95.

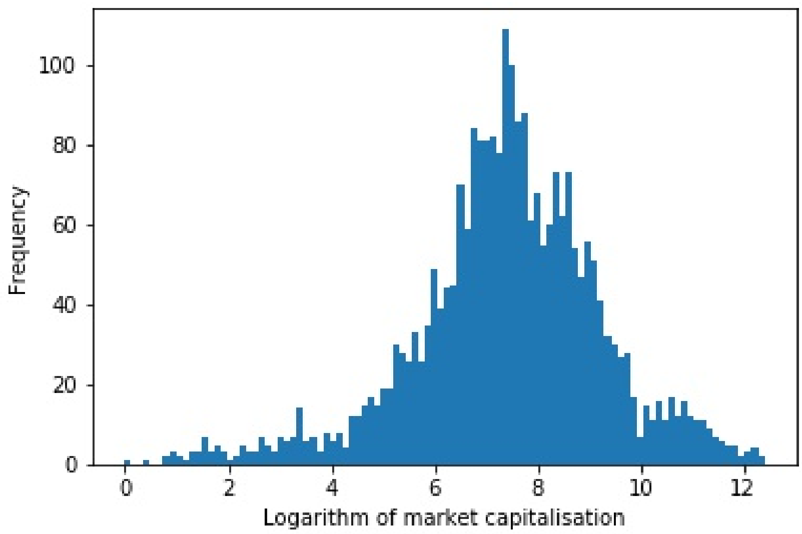

Fig. 5.4. The figure plots the histogram of the logarithm of market capitalisation in million dollars for firms in ASX 200 from 2000 to 2018. The skewness of the logarithm of market capitalisation is -0.4953.

Table 5.2: Pearson correlation matrix

This table reports the Pearson correlation matrix of variables for a sample of ASX 200 firms between 2000 and 2018. *LFB* is the natural logarithm of franking credit balances. *LBVA* is the natural logarithm of the book value of assets. *INTO* is the percentage of international ownership calculated as the ratio of the number of shares owned by international investors over the number of shares outstanding. *INDO* is the percentage of individual ownership calculated as the ratio of the number of shares owned by individual investors over the number of shares outstanding. *PROF* is calculated as net profit after tax to total revenue as the proxy for profitability. *LEV* is calculated as total liabilities to book value of assets as the proxy for leverage. *GO* is calculated as research and development (R&D) expenditure to total revenue as the proxy for growth options. *LMC* is the natural logarithm of market capitalisation. *LNTA* is the natural logarithm of net assets. $LEARN_t$ is the natural logarithm of earnings. $LEARN_{t+1}$ is the natural logarithm of future earnings. The numbers shown in underlined and bold indicate significance at the 5% and 1% levels, respectively.

	LFB	*LBVA*	*INTO*	*INDO*	*PROF*	*LEV*	*GO*	*LMC*	*LNTA*	$LEARN_t$	$LEARN_{t+1}$
LFB	1										
LBVA	**0.6272**	1									
INTO	**-0.1156**	**-0.1193**	1								
INDO	-0.0382	**-0.2179**	**-0.1083**	1							
PROF	0.0514	-0.0033	-0.0068	-0.0592	1						
LEV	**0.3030**	**0.5818**	-0.0295	0.0519	**-0.0998**	1					
GO	**-0.1794**	**-0.2546**	**0.2140**	**0.0804**	-0.0135	**-0.1209**	1				
LMC	**0.6762**	**0.8753**	**-0.1407**	**-0.2360**	0.0122	**0.3525**	**-0.1403**	1			
LNTA	**0.6337**	**0.9483**	**-0.1362**	**-0.2959**	0.0210	**0.3231**	**-0.2614**	**0.9047**	1		
$LEARN_t$	**0.6433**	**0.8614**	**-0.1331**	**-0.2125**	0.0036	**0.3752**	**-0.1810**	**0.9224**	**0.8798**	1	
$LEARN_{t+1}$	**0.6500**	**0.8671**	**-0.1108**	**-0.2331**	0.0203	**0.3752**	**-0.1841**	**0.9304**	**0.8902**	**0.9219**	1

5.5.3 Regression results

To analyse the determinants of franking credit balances, Eq. (5.2) is applied to validate the size effect, the international focus effect, and the individual dividend clientele effect described in hypotheses 5.1, 5.2, and 5.3. Table 5.3 provides the OLS regression results of Eq. (5.2). Panel A examines the size effect and the international focus effect using the sample from 1996 to 2013[4]. Panel B examines these effects using the extended sample from 2000 to 2018. Panel C examines the individual dividend clientele effect using the sample from 2000 to 2018. The coefficients on firm size (*LBVA*) are positive and statistically significant at 5% in all panels, providing strong evidence of the size effect. The coefficients on logarithm variables measure the elasticity of the dependent variable with respect to the independent variable. The coefficient on *LBVA* of 0.4922 in Panel B represents the elasticity of franking credit balances with respect to firm size. It indicates that one percent increase in firm size contributes to a half percent increase in the level of franking credit balances. The evidence of the size effect described in hypothesis 5.1 is consistent with Heaney (2009) and Tanza's (2014) findings. In the examination of the international focus effect, this chapter cannot replicate Tanza's (2014) findings using the sample of ASX 200 with the same examining period from 1996 to 2013 according to Panel A. However, the analysis finds weak evidence of the international focus effect using the sample from 2000 to 2018 according to the international ownership coefficient of 30.36 that is significant at 10% in Panel B. The findings are consistent with Tanza's (2014) findings. According to Panel C, the coefficient on the percentage of individual ownership ($INTO$) is negative and statistically significant at 1%, providing strong evidence to support the individual dividend clientele documented in hypothesis 5.3.

This chapter further conducts franking credit balances value relevance analysis by examining the sensitivity of firms' market capitalisation to franking credit balances. Table 5.4 reports the estimated coefficients in Eq. (5.3) and Eq. (5.4). We cannot replicate Tanza's (2014) findings by applying Eq. (5.3) using the sample of ASX 200 and the same examining period as used by Tanza (2014). From Panel A, the coefficients on FB are statistically insignificant. The difference in the franking credit balances coefficients between Tanza's (2014) results and results in Panel A could be caused by the sample selection[5]. After applying the two main improvements to reduce the skewness and the multicollinearity in Eq. (5.4), the analysis finds that coefficients on LFB are positive and statistically significant at 5% and 1% in Panel B and Panel C, respectively. The evidence confirms hypothesis 5.4 that franking credit balances are priced in the market, which confirms Tanza's (2014) findings but contradicts Heaney's (2009) findings using a sample of large firms.

[4]Panel A examines the period from 1996 to 2013 to replicate Tanza's (2014) work.

[5]Some outlier firms with large franking credit balances might affect the coefficient significantly. A positive coefficient of 0.8556 with significance at 1% on FB is obtained after excluding BHP from the sample.

The LFB coefficient that measures the elasticity of firm value with respect to franking credit balances is 0.04 in Panel B. It suggests that one percent increase in franking credit balances is associated with 0.04 percent increase in firm value. The elasticity of 0.04 can be interpreted that each dollar of franking credit balances is worth at approximately 1.4 dollars using the mean of franking credit balances and market capitalisation in summary statistics[6].

Table 5.5 reports the coefficients in Eq. (5.5) that incorporates the size interaction terms. From Panel A and Panel B, the coefficients on FB are statistically insignificant, and the coefficients on $D2_{MC} * LFB$ are positive and statistically significant at 1%. It indicates that the market valuation of franking credit balances is positive for firms with a market capitalisation above the median. Panel C and Panel D provide deeper insights into the relationship between the market valuation of franking credit balances and firm size by dividing the sample into quartiles based on market capitalisation. The coefficient on FB is negative and statistically significant, and the coefficients on $D1_{MC} * LFB$, $D2_{MC} * LFB$ and $D3_{MC} * LFB$ are all positive and statistically significant. This indicates that the firms with a market capitalisation below the lower quartile (25%) have a negative market valuation of franking credit balances. However, the market valuation of franking credit balances increases significantly and turns from negative into strongly positive with the increase of firm size. The findings verify hypothesis 5.5 and contradict Heaney's (2009) results.

Table 5.6 presents the coefficients in Eq. (5.6) that incorporates the international focus interaction terms. From Panel A and Panel B, the coefficients on LFB shift from positive and statistically significant to insignificant when interacting with $D2_{INTO}$. When all three international ownership dummies are incorporated into the model, the results provide more insights. For firms with international ownership below the lower quantile (25%), franking credit balances are marginally priced in the market. However, the market valuation of franking credit balances drops significantly with the increase of international ownership holdings, especially when the firm's international ownership is above the lower quartile (25%). It indicates that the market valuation of franking credit balances decreases with the international holdings when the international ownership exceeds the 25% percentile. The findings are consistent with hypothesis 5.7 and the second part of Heaney's (2009) proposition.

[6]The estimated utilisation ratio in dollar value of franking credit balances is derived by using the elasticity of 0.04 with a mean of FB at 212 and a mean of MC at 7397 presented in Table 5.1. One percentage increase in FB with a mean of 212 represents an increase of 2.12 dollars in FB. 0.04 percentage increase in MC with a mean of 7397 represents an increase of 2.96 dollars in MC. Therefore, one dollar increase in franking credit balances leads to a 1.4 dollars increase in market capitalisation. The market valuation of franking balance at more than \$1 is somewhat unexpected and warrants further investigation. It is possible that franking credit balances are a signal or indicator of the future dividend policy. Specifically, firms with higher franking credit balances might have strong current and expected future earnings and hence will have larger dividends and more franking credits to distribute in the future. It is also possible the franking balances disclosed by listed firms are inconsistently defined.

Table 5.3: Fixed company and fixed time effects panel OLS model estimates of franking credit balances determinant analysis

This table reports the estimates of coefficients from fixed company and fixed time effects panel OLS model Eq. (5.2). *LFB* is the dependent variable. *LFB* is the natural logarithm of franking credit balances. *LBVA* is the natural logarithm of the book value of assets. *INTO* is the percentage of international ownership calculated as the ratio of the number of shares owned by international investors over the number of shares outstanding. *INDO* is the percentage of individual ownership calculated as the ratio of the number of shares owned by individual investors over the number of shares outstanding. *PROF* is calculated as net profit after tax to total revenue as the proxy for profitability. *LEV* is calculated as total liabilities to book value of assets as the proxy for leverage. *GO* is calculated as research and development (R&D) expenditure to total revenue as the proxy for growth options. Panel A examines the size effect and international focus effect using the sample from 1996 to 2013. Panel B examines the size effect and the international focus effect using the sample from 2000 to 2018. Panel C examines the individual dividend clientele effect using the sample from 2000 to 2018. The regression uses both time, and firm clusters and significance at the 10%, 5%, and 1% levels is indicated by *, **, and ***, respectively. T-statistics are reported in parentheses.

LFB	Panel A	Panel B	Panel C
Sample period	1996-2013	2000-2018	2000-2018
CONST	0.7571 (0.5982)	0.0507 (0.0602)	1.5139 (3.1073)
LBVA	0.426 (2.4084)**	0.4922 (4.3681)***	0.3435 (5.2396)***
INTO	19.525 (0.9804)	30.3679 (1.6808)*	
INDO			-0.9420 (-2.5832)***
LEV	-1.0071 (-1.5666)	-0.9078 (-1.5214)	-0.8234 (-2.1061)**
PROF	0.0024 (5.975)***	0.0009 (3.4194)***	0.001 (1.164)
GO	-0.8327 (-0.3536)	-0.2871 (-0.2159)	-0.1089 (-0.1244)
No of observations	753	1319	1407
R-squared	36.18%	35.23%	28.52%

Table 5.4: Fixed company and fixed time effects panel OLS model estimates of franking credit balances valuation relevance analysis

This table reports the estimates of coefficients from fixed company and fixed time effects panel OLS Eq. (5.4). *LMC* is the dependent variable. *LMC* is the natural logarithm of market capitalisation. *MC* is the market capitalisation. *LFB* is the natural logarithm of franking credit balances. *FB* is the franking credit balances. *LNTA* is the natural logarithm of net assets. $LEARN_t$ is the natural logarithm of earnings. $EARN_t$ is earnings. $LEARN_{t+1}$ is the natural logarithm of future earnings. $EARN_{t+1}$ is future earnings. Panel A examines the market valuation of franking credit balances by applying Tanza's (2014) method using the sample from 1996 to 2013. Panel B examines the market valuation of franking credit balances after log-transformation with $LEARN_t$ as the proxy for future residual income using the sample from 2000 to 2018. Panel C examines the market valuation of franking credit balances after log-transformation with $LEARN_{t+1}$ as the proxy for future residual income using the sample from 2000 to 2018. The regression uses both time, and firm clusters and significance at the 10%, 5%, and 1% levels is indicated by *, **, and ***, respectively. T-statistics are reported in parentheses.

	Panel A		Panel B	Panel C
Dependent variable	*MC*	Dependent variable	*LMC*	*LMC*
Sample period	1996-2013	Sample period	2000-2018	2000-2018
CONST	1522.7922 (1.5029)	*CONST*	2.7775 (8.0877)***	2.2643 (7.1192)***
FB	0.2776 (0.1136)	*LFB*	0.0395 (1.9981)**	0.0526 (2.7443)***
NTA	0.7232 (2.4639)**	*LNTA*	0.5058 (7.9326)***	0.5811 (10.3742)***
$EARN_t$	5.0306 (2.4825)**	$LEARN_t$	0.2797 (7.182)***	
$EARN_{t+1}$	2.2748 (3.0639)***	$LEARN_{t+1}$		0.2613 (8.0351)***
No of observations	1035		1533	1531
R-squared	90.76%		87.5%	87.6%

Table 5.5: Fixed company and fixed time effects panel OLS model estimates of franking credit balances valuation relevance analysis with the size effect

This table reports the estimates of coefficients from fixed company and fixed time effects panel OLS Eq. (5.5). *LMC* is the dependent variable. *LMC* is the natural logarithm of market capitalisation. *LFB* is the natural logarithm of franking credit balances. *MC* is the market capitalisation. $D1_{MC}$ takes the value of one when $MC_{j,t}$ is above the lower (25%) quartile of MC_t across all companies in year t and zero otherwise. $D2_{MC}$ takes the value of one when $MC_{j,t}$ is above the median of MC_t across all companies in year t and zero otherwise. $D3_{MC}$ takes the value of one when $MC_{j,t}$ is above the upper (75%) quartile of MC_t across all companies in year t and zero otherwise. *LNTA* is the natural logarithm of net assets. $LEARN_t$ is the natural logarithm of earnings. $LEARN_{t+1}$ is the natural logarithm of future earnings. Panel A uses $LEARN_t$ as the proxy for future residual income and $D2_{MC}$ as the firm size dummy in the interaction terms. Panel B uses $LEARN_{t+1}$ as the proxy for future residual income and $D2_{MC}$ as the firm size dummy in the interaction terms. Panel C uses $LEARN_t$ as the proxy for future residual income and $D1_{MC}$, $D2_{MC}$, $D3_{MC}$ as the firm size dummies in the interaction terms. Panel D uses $LEARN_{t+1}$ as the proxy for future residual income and $D1_{MC}$, $D2_{MC}$, $D3_{MC}$ as the firm size dummies in the interaction terms. The regression uses both time, and firm clusters and significance at the 10%, 5%, and 1% levels is indicated by *, **, and ***, respectively. T-statistics are reported in parentheses.

LMC	Panel A	Panel B	Panel C	Panel D
CONST	2.8452 (8.0257)***	2.325 (6.8453)***	2.9259 (22.3844)***	2.3902 (18.3049)***
LFB	0.0004 (0.0156)	0.0131 (0.6193)	-0.0522 (-3.6676)***	-0.0304 (-2.1995)**
$D1_{MC} * LFB$			0.0706 (5.7704)***	0.0632 (5.108)***
$D2_{MC} * LFB$	0.0606 (3.5518)***	0.0627 (3.7051)***	0.0431 (4.3951)***	0.0458 (4.6213)***
$D3_{MC} * LFB$			0.0254 (2.6048)***	0.019 (1.8996)*
LNTA	0.4988 (7.8403)***	0.5715 (9.8928)***	0.4892 (22.1845)***	0.562 (26.4955)***
$LEARN_t$	0.2734 (7.1424)***		0.264 (19.0969)***	
$LEARN_{t+1}$		0.2595 (8.0686)***		0.2531 (18.5956)***
No of observations	1533	1531	1533	1531
R-squared	88.63%	88.46%	89.36%	88.85%

Table 5.6: Fixed company and fixed time effects panel OLS model estimates of franking credit balances valuation relevance analysis with the international focus effect

This table reports the estimates of coefficients from fixed company and fixed time effects panel OLS Eq. (5.6). LMC is the dependent variable. LMC is the natural logarithm of market capitalisation. LFB is the natural logarithm of franking credit balances. $INTO$ is the percentage of international ownership calculated as the ratio of the number of shares owned by international investors over the number of shares outstanding. $D1_{INTO}$ takes the value of one when $INTO_{j,t}$ is above the lower (25%) quartile of $INTO_t$ across all companies in year t and zero otherwise, $D2_{INTO}$ takes the value of one when $INTO_{j,t}$ is above the median of $INTO_t$ across all companies in year t and zero otherwise, $D3_{INTO}$ takes the value of one when $INTO_{j,t}$ is above the upper (75%) quartile of $INTO_t$ across all companies in year t and zero otherwise. $LNTA$ is the natural logarithm of net assets. $LEARN_t$ is the natural logarithm of earnings. $LEARN_{t+1}$ is the natural logarithm of future earnings. Panel A uses $LEARN_t$ as the proxy for future residual income and $D2_{INTO}$ as the international ownership dummy in the interaction terms. Panel B uses $LEARN_{t+1}$ as the proxy for future residual income and $D2_{INTO}$ as the international ownership dummy in the interaction terms. Panel C uses $LEARN_t$ as the proxy for future residual income and $D1_{INTO}$, $D2_{INTO}$, $D3_{INTO}$ as the international ownership dummies in the interaction terms. Panel D uses $LEARN_{t+1}$ as the proxy for future residual income and $D1_{INTO}$, $D2_{INTO}$, $D3_{INTO}$ as the international ownership dummies in the interaction terms. The regression uses both time, and firm clusters and significance at the 10%, 5%, and 1% levels is indicated by *, **, and ***, respectively. T-statistics are reported in parentheses.

LMC	Panel A	Panel B	Panel C	Panel D
$CONST$	2.778 (8.0971)***	2.2651 (7.1104)***	2.7804 (20.7675)***	2.2702 (17.0463)***
LFB	0.0384 (1.8651)*	0.0531 (2.6835)***	0.0461 (4.1668)***	0.0639 (5.9328)***
$D1_{INTO}$			-0.0158 (-1.9636)**	-0.0235 (-2.8699)***
$D2_{INTO}$	0.0027 (0.2808)	-0.0014 (-0.1395)	0.0088 (1.1209)	0.0081 (1.0146)
$D3_{INTO}$			-0.003 (-0.3261)	-0.0049 (-0.5173)
$LNTA$	0.5054 (7.9232)***	0.5812 (10.3701)***	0.5059 (22.2889)***	0.5805 (26.8416)***
$LEARN_t$	0.2802 (7.1268)***		0.2792 (19.682)***	
$LEARN_{t+1}$		0.2611 (7.9887)***		0.2617 (18.8147)***
No of observations	1533	1531	1533	1531
R-squared	87.55%	87.58%	87.39%	87.45%

5.6 Conclusion and original contribution

In the franking credit balances determinants analysis, Heaney (2009) and Tanza's (2014) find consistent evidence of a size effect and mixed evidence of an international focus effect. This chapter improves Heaney's (2009) model by using the percentage of international ownership as the proxy of international focus. The fixed company and fixed time effects panel data OLS regression uses the sample of ASX 200 from 2000 to 2018 and provides strong evidence of the size effect that the level of franking credit balances increases with firm size and weak evidence of the international focus effect that the level of franking credit balances increases with international ownership. This chapter proposes the individual dividend clientele effect hypothesis that firms with higher individual ownership are less likely to accumulate their franking credit balances as individual investors irrationally prefer franking credits to capital gains, as documented in Chapter 4. There is strong evidence of the individual dividend clientele effect.

In the value relevance tests, this chapter improves Tanza's (2014) value relevance model by applying a log-transformation to reduce the skewness of variables and using only one earnings variables to eliminate the multicollinearity and finds that franking credit balances are priced in the market. A one percent increase in the level of franking credit balances leads to a 0.04 percent increase in firm value. One dollar of franking credit balances is worth $1.4 dollars in firm value. The findings are consistent with Tanza's (2014) findings that using the sample of ASX 100, but contradict Heaney's (2009) findings that franking credit balances are not valued for his sample of large firms.

This chapter further relates the market valuation of franking credit balances with firm size and international focus. The findings suggest that the market valuation of franking credit balances increases with firm size, which contrasts Heaney's (2009) findings. To verify Heaney's (2009) proposition that large firms tend to attract more international investors who place less value to franking credit balances, this chapter provides evidence that the market valuation of franking credit balances decreases with the international ownership holdings. This is consistent with part of Heaney's (2009) argument. However, overall the data reveals a negative relationship between firm size and the percentage of international ownership holdings. The market valuation of franking credit balances is more significant in large firms, as large firms have a lower percentage of international investors who place a lower valuation on franking credit balances.

To conclude, as discussed in Section 2.4.4, franking credit balances studies are scarce in extant literature. This chapter provides insights into whether franking credit balances are priced in the market through value relevance tests and the determinant analysis. The panel data analysis provides direct evidence of the size effect, the international focus effect, and the individual dividend clientele effect in the determinant analysis. The analysis also suggests that franking credit balances are priced in the market, and that their valuation is positively related to the firm size but negatively related to international focus. Accordingly, the building up of franking credit balances over time in Australian firms provides a significant notional tax benefit to resident investors. The findings provide insights into the marked differences in the literature of the valuation of franking credits and provide direct evidence to support the argument that franking credits are reflected in share prices in the Australian equity market.

Chapter 6

Conclusion

The imputation system in Australia, as an important mechanism that supports the integration of corporate and personal tax systems, is playing a vital role in the Australian economy in terms of avoiding double taxation of corporate earnings, protecting the welfare of eligible investors and improving the attractiveness of Australian firms to certain investors (Australian Government, 2015). On the other hand, according to Australian Government (2014), this system is under the risk of being modified or even completely revoked due to its unattractiveness to international investment communities and thus the increased required rate of return of foreign investors. The topic of whether or not the imputation system should be modified is controversial among academics and practitioners. The question central to this debate—"Are franking credits attached in the imputation system priced in the market?"—has raised broad attention in the literature with consensus yet to be reached. This thesis aims to shed light on this question and examines the pricing of franking credits through three interrelated studies, namely, the pricing BHP Billiton ADR twins, the pricing of equities in the ex-dividend period, and the valuation of franking credit balances.

Chapter 3 investigates the role of the tax imputation system in the price premium of BHP Billiton ADR twins. In particular, BHP in Australia and Billiton in the UK form a Dual-Listed Company (DLC) and their ADRs are traded on the NYSE. Despite the same US dollar dominated dividends, the BHP ADR generally sells at a premium to the Billiton ADR with a considerable time variation. With the application of Gordon Growth Model (GGM) (Gordon and Shapiro, 1956) and Residual Income Model (RIM) (Ohlson, 1995) for price estimation and multivariate OLS regression models, we find that imputation tax differences significantly explain the time variation in the premium of the ADR prices and thus are an important determinant of the premium.

Chapter 4 explores the implications of franking credits on the ex-dividend period irrational exuberance in the context of the Australian equity market. Specifically, we validate the existence of the exuberance and the dividend clienteles which potentially lead to the exuberance, and further investigate the role of franking credits in the dividend clienteles. We find that individual investors irrationally overvalue dividends and franking credits due to behavioural finance reasons, and hence shifts from a long position to a short position during an ex-dividend event. These behaviours thus contribute to the ex-dividend period exuberance. In addition, there is no evidence relating foreign ownership with the valuation of franking credits.

Chapter 5 examines the valuation of franking balance for Australian firms through a determinant analysis and value relevance studies. The determinant analysis investigates the factors that contribute to the increasing cumulative level of franking credit balances in Australia. The fixed company and fixed time effects panel data OLS regression provides strong evidence of the size effect that the level of franking credit balances increases with firm size and weak evidence of the international focus effect that the level of franking credit balances increases with international ownership. Value relevance studies explore whether franking credit balances are priced in the market. With extensions and improvements based on Tanza's (2014) value relevance model, we find significant evidence that franking credit balances are priced in the market and one dollar of franking credit is worth 1.4 dollars in firm value. In addition, this chapter relates the market valuation of franking credit balances to firm size and international focus and suggests that the market valuation is positively correlated with the firm size and negatively correlated with international focus.

Overall, the above three studies address different aspects regarding the question of whether franking credits are priced in the Australian and international equity markets, and thus provide insights on the debate of whether the imputation system in Australia should be abandoned or modified. Significant evidence is provided, which shows that franking credits are priced and are providing massive benefits to Australian resident investors. Our findings suggest that the imputation system should not be removed without a change in other tax rules, in which case share prices in the Australian equity market are expected to drop sharply with a substantial loss of resident investors' welfare.

This thesis contributes to several different streams of literature. First, it contributes to the two main streams of literature that investigate the pricing of franking credits, namely, comparative pricing studies and ex-dividend drop-off studies. Chapter 3 extends the comparative pricing studies by proposing a new approach that compares the prices of two instruments which are same in their underlying but differ in their entitlement to franking credits (i.e. ADRs of DLC twins). It provides the first direct evidence that imputation tax credits are capitalised into equity prices. Chapter 4 extends the ex-dividend drop-off studies literature by examining the overall influence of dividends and franking credits for the whole ex-dividend period. While most existing ex-dividend drop-off studies intentionally restrict their investigation window to short periods around the ex-dividend day, we apply a wider range of the examining window (5-day, 10-day, 20-day, 30-day, 40-day, 50-day) surrounding the ex-dividend date.

Second, this thesis contributes to the literature on the valuation of franking credit balances, which has been scarce to date with Heaney (2009) and Tanza (2014) being the only closely relevant studies. In the analysis of determinants contributing to the level of franking credit balances, Heaney (2009) fails to find evidence to confirm the international focus effect due to the difficulty in identifying ownership constituents. Chapter 5 extends Heaney's (2009) work by replacing the ratio of non-resident revenue to total revenue with the percentage of international ownership as the proxy of international focus to address the original limitation of the inability to access ownership data. In addition, Chapter 5 extends Tanza's (2014) value relevance model by applying the log-transformation to reduce the skewness of the sample and using earnings or future earnings in the model to deal with the multicollinearity between the independent variables in the model. These extensions significantly improve the statistical properties of investigated variables and model performance.

Third, this thesis contributes to the literature on applications of GGM and RIM as it provides evidence that tax factors should be considered in these two valuation models. In particular, Chapter 3 modifies the original GGM and RIM by replacing distributed dividends and residual income with after-tax dividends and after-tax residual income which incorporate personal tax rates and franking credits. The improved models successfully capture the impacts of tax factors on the price estimation of invested securities.

Finally, this thesis also contributes to the literature on dividend clienteles. In contrast to the classic tax-induced explanation of dividend clienteles (Feldstein and Green, 1983; Shleifer and Vishny, 1986; Redding, 1997; Brav and Heaton, 1998; Allen et al., 2000), Chapter 4 proposes a behavioural finance explanation of dividend clienteles in which individual investors overvalue the dividends and franking credits due to the "bird in the hand" fallacy, the "behavioural life-cycle" theory, and the "information signaling" theory, and thus prefer to take a long position before the ex-dividend date and to sell those securities afterwards. This forms an important factor that contributes to the ex-dividend period irrational exuberance. Chapter 5 further presents strong evidence of the individual dividend clientele effect that firms with higher individual ownership are less likely to accumulate their franking credit balances as individual investors irrationally prefer franking credits to capital gains.

While this thesis makes important novel contributions to the literature, there are some limitations, and potential future extensions can be identified in the following ways. For Chapter 3.1, further research can be structured to investigate the relationship between the mispricing and US-domiciled ownership holdings of the BHP twins. There are potentially three tax-heterogeneous groups of investors, the first being Australian investors who are eligible for Australian imputation credits, the second being UK investors who are eligible for the UK imputation, and the third group being investors in other countries (e.g., especially the US) who are not eligible for any imputation benefits. Consider an extreme case where the BHP twins are 100% held by all US investors. There should be no tax effects of imputation in these circumstances. On the other hand, the tax effect will be maximised when foreign ownership of BHP and Billiton is zero. Research could be conducted to investigate the proportion of the BHP twins held by ADR investors in the US and the mispricing of the twins. Chapter 5 investigates the impact of franking credit balances on share prices, while its impact on the cost of equity is unclear. Future research can be conducted by combining franking credit balances studies and the required rate of return studies to examine whether the level of franking credit balances can reduce the required rate of return.

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Appendix A

Historical tax rate in Australia

Table A.1: History of tax rates in Australia .

The table reports the history of tax rates including corporate tax rates, top personal income tax rates, medicare levy rates and capital gain tax rates for individual investors, income tax rate and capital gain tax rate for superannuation funds, in Australia from 1985 to 2020. Capital gain tax rate is half of the personal income tax rate for individual, and two thirds of the income tax rate for superannuation funds. All of the tax rates are in the top level tax brackets (The Treasury, 2012; Australian Taxation Office, 2020c,i,j,l,k).

year	Company	Individual			Superannuation funds	
	corporate tax rate	top income tax rate	Medicare levy	Capital gain tax rate	income tax rate	Capital gain tax rate
1985-1986	46%	60%	1%	61%	15%	15%
1986-1987	49%	57.08%	1.25%	58.33%	15%	15%
1987-1988	49%	49%	1.25%	50.25%	15%	15%
1988-1989	39%	49%	1.25%	50.25%	15%	15%
1989-1990	39%	48%	1.25%	49.25%	15%	15%
1990-1991	39%	47%	1.25%	48.25%	15%	15%
1991-1992	39%	47%	1.25%	48.25%	15%	15%
1992-1993	39%	47%	1.25%	48.25%	15%	15%
1993-1994	33%	47%	1.4%	48.4%	15%	15%
1994-1995	33%	47%	1.4%	48.4%	15%	15%

1995-1996	36%	47%	1.5%	48.5%	15%	15%
1996-1997	36%	47%	1.7%	48.7%	15%	15%
1997-1998	36%	47%	1.5%	48.5%	15%	15%
1998-1999	36%	47%	1.5%	48.5%	15%	15%
1999-2000	36%	47%	1.5%	24.25%	15%	10%
2000-2001	34%	47%	1.5%	24.25%	15%	10%
2001-2002	30%	47%	1.5%	24.25%	15%	10%
2002-2003	30%	47%	1.5%	24.25%	15%	10%
2003-2004	30%	47%	1.5%	24.25%	15%	10%
2004-2005	30%	47%	1.5%	24.25%	15%	10%
2005-2006	30%	47%	1.5%	24.25%	15%	10%
2006-2007	30%	45%	1.5%	23.25%	15%	10%
2007-2008	30%	45%	1.5%	23.25%	15%	10%
2008-2009	30%	45%	1.5%	23.25%	15%	10%
2009-2010	30%	45%	1.5%	23.25%	15%	10%
2010-2011	30%	45%	1.5%	23.25%	15%	10%
2011-2012	30%	45%	1.5%	23.25%	15%	10%
2012-2013	30%	45%	1.5%	23.25%	15%	10%
2013-2014	30%	45%	1.5%	23.25%	15%	10%
2014-2015	30%	45%	2%	23.5%	15%	10%
2015-2016	30%	45%	2%	23.5%	15%	10%
2016-2017	30%	45%	2%	23.5%	15%	10%
2017-2018	30%	45%	2%	23.5%	15%	10%
2018-2019	30%	45%	2%	23.5%	15%	10%
2019-2020	30%	45%	2%	23.5%	15%	10%

Appendix B

Comparison of historical tax rates between Australia and the UK

Table B.1 and Table B.2 report the historical corporate tax rate, franking credits tax rate, the top marginal personal dividend tax rate, Medicare levy, and the effective tax rate from 2001 to 2018 in Australia and the UK respectively. Table B.3 reports the dividend information including the dividend announcement date, the ex-dividend date, the dividend payment date, and dividend amount (in USD) of BHP from 2001 to 2018[1].

Table B.1: Change of historical tax rate in Australia

The table reports historical corporate tax rate (τ_c), franking credits tax rate (F), top marginal personal income tax rate (τ_p), medicare levy (τ_m), and the effective tax rate for dividends (τ_e)[2] in Australia from 2001 to 2018.

Date from	Date to	τ_c	F	τ_p	τ_m	τ_e
Jul 1, 2001	Jun 30, 2006	30%	30%	47%	1.5%	26.43%
Jul 1, 2006	Jun 30, 2014	30%	30%	45%	1.5%	23.57%
Jul 1, 2014	Jun 30, 2018	30%	30%	45%	2%	24.29%

[1]BHP dividends for the examining period are all fully franked according to the annual reports. The same amount of dividend per share is declared for both BHP in Australia and Billiton in the UK.

[2]The calculation of effective tax rate in Australia is described in Eq. (3.5) in section 3.5.2.

[3]The calculation of effective tax rate in the UK is described in Eq. (3.4) in section 3.5.2.

Table B.2: Change of historical tax rate in the UK

The table reports historical corporate tax rate (τ_c), franking credits tax rate (F), top marginal personal income tax rate (τ_p), and the effective tax rate for dividends (τ_e)[3] in the UK from 2001 to 2018.

Date from	Date to	τ_c	F	τ_p	τ_e
Apr 6, 2001	Apr 5, 2008	30%	10%	32.5%	25%
Apr 6, 2008	Apr 5, 2009	28%	10%	32.5%	25%
Apr 6, 2010	Apr 5, 2011	26%	10%	42.5%	36.11%
Apr 6, 2011	Apr 5, 2012	24%	10%	42.5%	36.11%
Apr 6, 2012	Apr 5, 2013	23%	10%	42.5%	36.11%
Apr 6, 2013	Apr 5, 2014	21%	10%	37.5%	30.56%
Apr 6, 2014	Apr 5, 2016	20%	10%	37.5%	30.56%
Apr 6, 2016	Apr 5, 2018	19%	10%	38.1%	31.22%

Table B.3: Dividend information of BHP

The table reports the ex-dividend date, the dividend announcement date, the dividend payment date, and the dividend amount in USD of BHP from 2001 to 2018.

The dividend announcement date	The ex-dividend date	The dividend payment date	Dividend amount
Nov 7, 2001	Nov 13, 2001	Dec 5, 2001	$ 0.065
May 3, 2002	Jun 4, 2002	Jul 3, 2002	$ 0.065
Oct 31, 2002	Nov 12, 2002	Dec 4, 2002	$ 0.07
May 7, 2003	Jun 10, 2003	Jul 2, 2003	$ 0.075
Oct 29, 2003	Nov 10, 2003	Dec 3, 2003	$ 0.08
Mar 23, 2004	Apr 13, 2004	May 5, 2004	$ 0.085
Aug 18, 2004	Sep 1, 2004	Sep 22, 2004	$ 0.095
Feb 28, 2005	Mar 2, 2005	Mar 23, 2005	$ 0.135
Aug 24, 2005	Sep 7, 2005	Sep 28, 2005	$ 0.145
Feb 15, 2006	Mar 1, 2006	Mar 22, 2006	$ 0.175
Aug 23, 2006	Sep 6, 2006	Sep 27, 2006	$ 0.185
Feb 7, 2007	Feb 28, 2007	Mar 20, 2007	$ 0.2
Aug 22, 2007	Sep 12, 2007	Sep 28, 2007	$ 0.27
Feb 6, 2008	Feb 27, 2008	Mar 18, 2008	$ 0.29
Aug 18, 2008	Sep 3, 2008	Sep 25, 2008	$ 0.41
Feb 4, 2009	Feb 25, 2009	Mar 17, 2009	$ 0.41
Aug 12, 2009	Sep 2, 2009	Sep 25, 2009	$ 0.41
Feb 10, 2010	Mar 3, 2010	Mar 23, 2010	$ 0.42
Aug 25, 2010	Sep 8, 2010	Sep 30, 2010	$ 0.45
Feb 16, 2011	Mar 9, 2011	Mar 31, 2011	$ 0.46
Aug 24, 2011	Sep 7, 2011	Sep 29, 2011	$ 0.55
Feb 8, 2012	Feb 29, 2012	Mar 22, 2012	$ 0.55
Aug 22, 2012	Sep 5, 2012	Sep 28, 2012	$ 0.57
Feb 20, 2013	Mar 6, 2013	Mar 28, 2013	$ 0.57
Aug 20, 2013	Sep 4, 2013	Sep 25, 2013	$ 0.59
Feb 18, 2014	Mar 5, 2014	Mar 26, 2014	$ 0.59
Aug 19, 2014	Sep 3, 2014	Sep 23, 2014	$ 0.62
Feb 24, 2015	Mar 11, 2015	Mar 31, 2015	$ 0.62
Aug 25, 2015	Sep 9, 2015	Sep 29, 2015	$ 0.62
Feb 23, 2016	Mar 9, 2016	Mar 31, 2016	$ 0.16
Aug 16, 2016	Aug 31, 2016	Sep 20, 2016	$ 0.1
Feb 21, 2017	Mar 8, 2017	Mar 28, 2017	$ 0.4
Aug 22, 2017	Sep 7, 2017	Sep 26, 2017	$ 0.43
Feb 20, 2018	Mar 8, 2018	Mar 27, 2018	$ 0.55
Aug 21, 2018	Sep 6, 2018	Sep 25, 2018	$ 0.63

Appendix C

Residual income model

C.1 Derivation of residual income model

This section introduces the derivation from dividend discount model to residual income model. Dividend discount model is stated as

$$P_t = \sum_{\tau=1}^{\infty} \frac{E_t[DIV_{t+\tau}]}{(1+r)_\tau}, \tag{C.1}$$

where P_t is the price of the firm's equity at time t, $DIV_{t+\tau}$ is the net dividend paid at time $t+\tau$, r is the (assumed constant) discount rate. The clean surplus accounting relation is shown as:

$$b_t = b_{t-1} + X_t - DIV_t, \tag{C.2}$$

that can be rearranged to

$$DIV_t = b_t + X_t - b_{t-1}, \tag{C.3}$$

where b_t is the book value of equity at time t, X_t is the earnings for the period from $t-1$ to t. Substitute Eq. C.3 into Eq. C.1:

$$\begin{aligned}
P_t = & \sum_{\tau=1}^{\infty} \frac{E_t[b_{t+\tau-1} + X_{t+\tau} - b_{t+\tau}]}{(1+r)^{\tau}} \\
= & \frac{E[b_t + X_{t+1} - b_{t+1}]}{(1+r)} + \frac{E[b_{t+1} + X_{t+2} - b_{t+2}]}{(1+r)^2} + \frac{E[b_{t+2} + X_{t+3} - b_{t+3}]}{(1+r)^3} + \ldots \\
= & \{\frac{E[b_t + X_{t+1}]}{(1+r)} + \frac{-E[b_{t+1}]}{(1+r)}\} + \{\frac{E[b_{t+1} + X_{t+2}]}{(1+r)^2} + \frac{-E[b_{t+2}]}{(1+r)^2}\} + \{\frac{E[b_{t+2} + X_{t+3}]}{(1+r)^3} + \frac{-E[b_{t+3}]}{(1+r)^3}\} + \ldots \\
= & \{E[b_t] + \frac{E[X_{t+1} - r * b_t]}{(1+r)} + \frac{-E[b_{t+1}]}{(1+r)}\} + \{\frac{E[b_{t+1}]}{(1+r)} + \frac{E[X_{t+2} - r * b_{t+1}]}{(1+r)^2} + \frac{-E[b_{t+2}]}{(1+r)^2}\} \\
& + \ldots + \{\frac{E[b_{t+\infty-1}]}{(1+r)} + \frac{E[X_{t+\infty} - r * b_{t+\infty-1}]}{(1+r)^{\infty}} + \frac{-E[b_{t+\infty}]}{(1+r)^{\infty}}\} \\
= & E[b_t] + \frac{E[X_{t+1} - r * b_t]}{(1+r)} + \{\frac{-E[b_{t+1}]}{(1+r)} + \frac{E[b_{t+1}]}{(1+r)}\} + \frac{E[X_{t+2} - r * b_{t+1}]}{(1+r)^2} + \{\frac{-E[b_{t+2}]}{(1+r)^2} + \frac{E[b_{t+2}]}{(1+r)^2}\} \\
& + \frac{E[X_{t+3} - r * b_{t+2}]}{(1+r)^3} + \ldots + \frac{-E[b_{t+\infty}]}{(1+r)^{\infty}} \\
= & b_t + \sum_{\tau=1}^{\infty} \frac{E_t[x_{t+\tau} - r * b_{t+\tau-1}]}{(1+r)^{\tau}} - \frac{E_t[b_{t+\infty}]}{(1+r)^{\infty}}.
\end{aligned} \tag{C.4}$$

The final term $\frac{E_t[b_{t+\infty}]}{(1+r)^{\infty}}$ in the Eq. C.4 is assummed to be zero, and 'residual income' or 'abnormal earnings' is defined as

$$X_t{}^a = X_t - r * b_{t-1}. \tag{C.5}$$

So that the price can be expressed as the sum of book value and the present value of future abnormal earnings:

$$P_t = b_t + \sum_{\tau=1}^{\infty} \frac{E_t[X_{d+\tau}{}^a]}{(1+r)^{\tau}}, \tag{C.6}$$

$$X_{t+\tau}{}^a = X_{t+\tau} - r * b_{t+\tau-1}, \tag{C.7}$$

where $X_{t+\tau}{}^a$ is residual income at time $t+\tau$, $X_{t+\tau}$ is net income at time $t+\tau$, r is the cost of equity, $b_{t+\tau-1}$ is the book value of equity at time $t+\tau-1$. Then the model incorporates personal tax rates and franking credits as

$$P_t = \sum_{\tau=1}^{\infty} \frac{E_t[DIV_{t+\tau}](1 - T_{p,t+\tau})}{(1 - F_{t+\tau})(1+r)^{\tau}}. \tag{C.8}$$

Substitute Eq. C.3 into Eq. C.8:

$$
\begin{aligned}
P_t = &\sum_{\tau=1}^{\infty} \frac{E_t[b_{t+\tau-1} + X_{d+\tau} - b_{t+\tau}](1-\pi_{t+\tau})}{(1-F_{t+\tau})(1+r)^{\tau}} \\
=&\frac{E_t[b_t + X_{t+1} - b_{t+1}](1-\pi_{t+1})}{(1-F_{t+1})(1+r)^1} \\
&+ \frac{E_t[b_{t+1} + X_{t+2} - b_{t+2}](1-\pi_{t+2})}{(1-F_{t+2})(1+r)^2} \\
&+ \frac{E_t[b_{t+2} + X_{t+3} - b_{d+3}](1-\pi_{t+3})}{(1-F_{t+3})(1+r)^3} + \ldots \\
=&\{\frac{E[b_t](1-\pi_{t+1})}{1-F_{t+1}} + \frac{E[b_{t+1} - r*b_t](1-\pi_{t+1})}{(1-F_{t+1})(1+r)} + \frac{-E[b_{t+1}]*(1-\pi_{t+1})}{(1-F_{t+1})(1+r)}\} \\
&+ \{\frac{E[b_{t+1}](1-\pi_{t+2})}{1-F_{t+2}} + \frac{E[b_{t+2} - r*b_{t+1}](1-\pi_{t+1})}{(1-F_{t+2})(1+r)^2} + \frac{-E[b_{t+2}]*(1-\pi_{t+2})}{(1-F_{t+2})(1+r)^2}\} + \ldots \\
&+ \{\frac{E[b_{t+\infty-1}]*(1-\pi_{t+\infty})}{(1-F_{t+\infty})} + \frac{E[b_{t+\infty} - r*b_{t+\infty-1}](1-\pi_{t+\infty})}{(1-F_{t+\infty})(1+r)^{\infty}} + \frac{-E[b_{t+\infty}]*(1-\pi_{t+\infty})}{(1-F_{t+\infty})(1+r)^{\infty}}\}.
\end{aligned}
\tag{C.9}
$$

We cannot simply cross out $\frac{-E[b_{t+1}]*(1-\pi_{t+1})}{(1-F_{t+1})(1+r)} + \frac{E[b_{t+1}]*(1-\pi_{t+1})}{(1-F_{t+1})(1+r)}$ to get the short cut shown in Eq. C.9 since the personal tax rates change across years. Therefore we cannot simply use the result in Eq. C.9 but we can still use the original version of residual income model:

$$
P_t = \sum_{\tau=1}^{\infty} \frac{E_t[b_{t+\tau-1} + X_{t+\tau} - b_{t+\tau}](1-\pi_{t+\tau})}{(1-F_{t+\tau})(1+r)^{\tau}}. \tag{C.10}
$$

C.2 The violations of the clean surplus relation

The clean surplus relation states that total closing equity equals total opening equity plus net income minus dividends and share buy-back. However, the relation does not hold perfectly in reality. This paper identifies the clean surplus violations (e.g., transactions with owners as owners, total changes in outside equity owners, contributed equity, Accrued employee entitlement to share awards) of BHP from 2001 to 2015. However, the violations during the period are immaterial (The percentage of the total violations of shareholders' equity is normally less than one per cent) except in years (2003 and 2015) where there are major restructurings.

Table C.1: The violations of the clean surplus relation

The table reports total opening equity, total closing equity, net income dividends, share buy-back and specific violating of the clean surplus relation of BHP from 2001 to 2015. Accounting data is collected from the Annual Report.

	Total opening equity	Net income	Dividends	Share buy-back	Other adjustments	Total closing equity
2001-2002	12,232	1,673	-784	-19		
Transactions with owners as owners					104	
Total changes in outside equity interests					-53	
Total clean surplus violation					51	
The percentage of total violations of net income					3.0484%	
The percentage of total violations of shareholders' equity					0.4018%	
(The average of total opening equity and closing equity)						
						13,153
2002-2003	13,153	1,927	-900	-20		
Transactions with owners as owners					-1,489	
Contributed equity					98	
Total changes in outside equity interests					-8	
Total adjustments					-1,399	
The percentage of total violations of net income					-72.5999%	
The percentage of total violations of shareholders' equity					-10.7973%	
(The average of total opening equity and closing equity)						

						12,761
2003-2004	12,761	3,451	-1,025			
Contributed equity					66	
Accrued employee entitlement to share awards					96	
Purchases of shares made by ESOP trusts					-25	
Total changes in outside equity interests					23	
Underestimation of reserves in Annual Report 2003					78	
Total adjustments					238	
The percentage of total violations of net income					6.8966%	
The percentage of total violations of shareholders' equity					1.6888%	
(The average of total opening equity and closing equity)						
						15,425
2004-2005	15,425	6,016	-1,409	-1,777		
Contributed equity					56	
Accrued employee entitlement to share awards					109	
Cash settlement of share awards					-3	
Purchases of shares made by ESOP trusts					-47	
Total changes in outside equity interests					-6	
Total adjustments					109	
The percentage of total violations of net income					1.8118%	
The percentage of total violations of shareholders' equity					0.6452%	
(The average of total opening equity and closing equity)						
						18,364
2005-2006	17,575	10,511	-1,938	-2,029		
Adjustment for adoption of IAS 39/AASB 139					201	
Contributed equity					24	
Accrued employee entitlement to share awards					61	
Purchases of shares made by ESOP trusts					-187	
Total adjustments					99	
The percentage of total violations of net income					0.9419%	

The percentage of total violations of shareholders' equity					0.4738%	
(The average of total opening equity and closing equity)						
						24,218
2006-2007	24,218	13,596	-2,269	-5,802		
Contributed equity					6	
Accrued employee entitlement to share awards					97	
Purchases of shares made by ESOP trusts					-231	
Total adjustments					-128	
The percentage of total violations of net income					-0.5590%	
The percentage of total violations of shareholders' equity					-0.2821%	
(The average of total opening equity and closing equity)						
						29,667
2007-2008	29,667	15,004	-3,133	-3,075		
Transactions with owners as owners					17	
Accrued employee entitlement to share awards					72	
Purchases of shares made by ESOP trusts					-165	
Total adjustments					-76	
The percentage of total violations of net income					-0.8531%	
The percentage of total violations of shareholders' equity					-0.3765%	
(The average of total opening equity and closing equity)						
						38,329
2008-2009	38,335	6,146	-4,563			
Accrued employee entitlement to share awards					185	
Purchases of shares made by ESOP trusts					-149	
Total adjustments					36	
The percentage of total violations of net income					0.5857%	
The percentage of total violations of shareholders' equity					0.0920%	
(The average of total opening equity and closing equity)						
						39,954
2009-2010	39,954	12,738	-4,618			

Transactions with owners as owners					-150	
Contributed equity					123	
Employee share awards reserve					146	
Financial assets reserve					-9	
Hedging reserve					123	
Non-controlling interest contribution reserve					350	
Foreign exchange					-9	
Total adjustments					451	
The percentage of total violations of net income					3.5406%	
The percentage of total violations of shareholders' equity					1.0195%	
(The average of total opening equity and closing equity)						
						48,525
2010-2011	48,525	23,637	-5,126	-9896		
Share buy-back and cancelled					-90	
Treasury shares					-98	
Contributed equity					-285	
Employee share awards reserve					123	
Financial assets reserve					-72	
Share buy-back reserve					46	
Non-controlling interest contribution reserve					-21	
Foreign exchange					19	
Total adjustments					-378	
The percentage of total violations of net income					-1.5992%	
The percentage of total violations of shareholders' equity					-0.7180%	
(The average of total opening equity and closing equity)						
						56,762
2011-2012	56,762	15,287	-5,894	-83		
Share buy-back and cancelled					2	
Treasury shares					90	
Accrued employee entitlement to share awards					-205	

Foreign currency translation reserve				19	
Employee share awards reserve				17	
Financial assets reserve				-46	
Share buy-back reserve				1	
Hedging reserve				-80	
Total adjustments				-202	
The percentage of total violations of net income				-1.3214%	
The percentage of total violations of shareholders' equity				-0.3294%	
(The average of total opening equity and closing equity)					
					65,870
2012-2013	65,870	10,962	-6,076		
Treasury shares				-7	
Divestment of jointly controlled entities				18	
Accrued employee entitlement to share awards				-161	
Foreign currency translation reserve				2	
Employee share awards reserve				-92	
Financial assets reserve				-90	
Hedging reserve				207	
Non-controlling interest contribution reserve				31	
Total adjustments				-92	
The percentage of total violations of net income				-0.8393%	
The percentage of total violations of shareholders' equity				-0.1348%	
(The average of total opening equity and closing equity)					
					70,664
2013-2014	70,667	13,901	-6,276		
Treasury shares				-47	
Accrued employee entitlement to share awards				-59	
Foreign currency translation reserve				-1	
Employee share awards reserve				-6	
Financial assets reserve				-25	

Hedging reserve				2	
Non-controlling interest contribution reserve				987	
Total adjustments				851	
The percentage of total violations of net income				6.1219%	
The percentage of total violations of shareholders' equity				1.1361%	
(The average of total opening equity and closing equity)					
					79,143
2014-2015	79,143	1,865	-6,296		
Share buy-back and cancelled				-12	
Treasury shares				511	
Accrued employee entitlement to share awards				114	
Foreign currency translation reserve				-2	
Employee share awards reserve				-227	
Financial assets reserve				-106	
Share buy-back reserve				12	
Hedging reserve				12	
Non-controlling interest contribution reserve				-59	
Transfer within equity on demerger				59	
BHP Billiton Plc shares cancelled				-501	
Demerger of aluminium, coal, manganese, nickel and silver assets				-9,445	
Total adjustments				-9,644	
The percentage of total violations of net income				-517.1046%	
The percentage of total violations of shareholders' equity				13.4027%	
(The average of total opening equity and closing equity)					
					64,768

Appendix D

Simple AR model to estimate dividends

Estimated dividends at time $t+1$ is stated as:

$$E(DIV_{t+1}) = DIV_{t-1} * (1+g_t), \tag{D.1}$$

where DIV_t is dividend flows at time t, g_t is the growth rate during the period t. We apply two main steps to estimate dividends. The conditional growth rate of dividend at time t is estimated by Autoregressive model of order 1 $(AR(1))$ using the sample of previous three dividends:

$$DIV_t = \varphi * DIV_{t-1} + \varepsilon_t, \tag{D.2}$$

where φ is the coefficient of the model. The estimated dividend at time $t+1$ is calculated by using dividend at time t multiplying the coefficient φ in Eq. D.2:

$$E(DIV_{t+1}) = \varphi * DIV_t. \tag{D.3}$$

The dividend on Mar 9, 2016 is excluded from the sample of the AR model because it is an outlier caused by a tailings dam collapse that led to an unexpected drop in the dividend[1].

[1]BHP abandoned its progressive dividend policy and slashed its interim dividend by 75 percent due to the costs associated with the Sanmarco tailings dam collapse in Brazil.

Appendix E

Robustness tests

The appendix reports the results of robustness tests in section 4.5.3 from chapter 4. Table E.1 replicates the OLS regression in Table 4.2 using multiple dividend variables and franking credit variables rather than dividend payout ratio *DPR* and frankming credits dividend ratio FDR. Table E.2 replicates the OLS regression in Table 4.3 by replacing the percentage of individual ownership *INDO* and the percentage of international ownership $INTO$ with the ownership dummy variables D_{INDO}/D_{INTO}. Table E.3 replicates the OLS regression in Table 4.4 using multiple dividend variables and franking credit variables rather than *DPR* and FDR. Overall, the results of robustness tests are similar to the results shown in section 4.5.3.

Table E.1: Robustness tests of Table 4.2

This table replicates Table 4.2 (OLS regressions for the ex-dividend period irrational exuberance) using multiple dividend variables and franking credits variables. *DPR* is the dollar amount of dividend per share divided by earnings per share during the previous year. *DY* is the dollar amount of dividend per share, divided by the cum-dividend day closing price. *FDR* is the dollar amount of franking credits per share divided by the dollar amount of dividend per share. *FL* is 0 if the dividend is unfranked while it is 100 if the dividend is with fully franked. It can range between 0 and 100 if the dividend is partly franked. *FD* is a dummy variable that takes the value of one if the dividend is fully franked credits and zero if it is unfranked or partly franked. *FPS* is the dollar amount of franking credit per share. *FCY* is the dollar amount of franking credit per share, divided by the cum-dividend closing price. $\overline{AAR}$ is the average daily abnormal adjusted return on the ex-dividend date, during the cum-dividend period and the ex-dividend period using 5-day, 10-day, 20-day, 30-day, 40-day and 50-day windows. The regression uses heteroskedasticity-consistent standard error estimator (Davidson and MacKinnon, 1993) and significance at the 10%, 5% and 1% levels is indicated by *, ** and ***, respectively. T-statistics are reported in parentheses.

$\overline{AAR}$	5-day	10-day	20-day	30-day	40-day	50-day
Panel A						
DY	0.05 (0.92)	0.04 (0.94)	0.03 (0.92)	0.01 (0.94)	0.02 (0.88)	0.01 (0.80)
$EX*DY$	-0.19 (0.85)	-0.13 (0.86)	-0.08 (0.83)	-0.05 (0.77)	-0.03 (0.82)	-0.01 (0.82)
FL	-0.00 (0.81)	0.00 (0.06)*	0.00 (0.06)*	0.00 (0.06)*	0.00 (0.02)**	0.00 (0.00)***
$EX*FL$	-0.00 (0.77)	-0.00 (0.00)***	-0.00 (0.02)**	-0.00 (0.01)***	-0.00 (0.00)***	-0.00 (0.01)***
Panel B						
DY	0.05 (0.93)	0.04 (0.94)	0.03 (0.92)	0.01 (0.93)	0.02 (0.88)	0.02 (0.80)
$EX*DY$	-0.19 (0.85)	-0.13 (0.86)	-0.08 (0.84)	-0.05 (0.77)	-0.03 (0.82)	-0.01 (0.82)
FD	-0.06 (0.27)	0.04 (0.23)	0.10 (0.06)*	0.12 (0.01)**	0.13 (0.00)***	0.09 (0.00)***
$EX*FD$	0.06 (0.42)	-0.12 (0.01)***	-0.13 (0.03)**	-0.15 (0.00)***	-0.15 (0.00)***	-0.09 (0.00)***
Panel C						
DY	0.05 (0.92)	0.04 (0.94)	0.02 (0.93)	0.01 (0.96)	0.01 (0.91)	0.01 (0.81)
$EX*DY$	-0.19 (0.85)	-0.13 (0.86)	-0.07 (0.84)	-0.04 (0.78)	-0.02 (0.84)	-0.01 (0.83)
FPS	-0.19 (0.31)	0.27 (0.04)**	0.45 (0.01)***	0.28 (0.02)**	0.21 (0.11)	0.15 (0.02)**
$EX*FPS$	0.23 (0.34)	-0.23 (0.15)	-0.35 (0.09)*	-0.05 (0.75)	-0.02 (0.90)	0.10 (0.28)

Panel D						
DY	0.05 (0.92)	0.04 (0.94)	0.03 (0.92)	0.01 (0.94)	0.02 (0.88)	0.01 (0.80)
$EX * DY$	-0.19 (0.85)	-0.13 (0.86)	-0.08 (0.83)	-0.05 (0.77)	-0.03 (0.82)	-0.01 (0.82)
FDR	-0.03 (0.81)	0.15 (0.06)*	0.28 (0.06)*	0.21 (0.06)*	0.27 (0.02)**	0.20 (0.00)***
$EX * FDR$	-0.05 (0.77)	-0.35 (0.00)***	-0.37 (0.02)**	-0.31 (0.01)***	-0.34 (0.00)***	-0.20 (0.01)***
Panel E						
DY	0.03 (0.96)	-0.00 (1.00)	-0.00 (0.92)	-0.01 (0.86)	-0.00 (0.96)	-0.00 (0.99)
$EX * DY$	-0.12 (0.90)	-0.05 (0.91)	-0.02 (0.80)	-0.01 (0.84)	-0.00 (0.97)	0.01 (0.96)
FCY	0.97 (0.88)	1.92 (0.74)	1.15 (0.72)	0.90 (0.71)	0.76 (0.68)	0.65 (0.53)
$EX * FCY$	-3.63 (0.58)	-3.62 (0.57)	-2.31 (0.51)	-1.44 (0.55)	-0.85 (0.69)	-0.79 (0.55)
Panel F						
DPR	0.14 (0.00)***	0.10 (0.00)***	0.04 (0.00)***	0.03 (0.00)***	0.02 (0.05)**	0.02 (0.01)**
$EX * DPR$	-0.15 (0.00)***	-0.13 (0.00)***	-0.06 (0.00)***	-0.03 (0.02)**	-0.03 (0.03)**	-0.02 (0.03)**
FL	0.00 (0.48)	0.00 (0.02)**	0.00 (0.06)*	0.00 (0.08)*	0.00 (0.02)**	0.00 (0.00)***
$EX * FL$	-0.00 (0.33)	-0.00 (0.00)***	-0.00 (0.02)**	-0.00 (0.02)**	-0.00 (0.01)***	-0.00 (0.01)***
Panel G						
DPR	0.14 (0.00)***	0.10 (0.00)***	0.04 (0.00)***	0.03 (0.00)***	0.02 (0.06)*	0.02 (0.02)**
$EX * DPR$	-0.15 (0.00)***	-0.13 (0.00)***	-0.06 (0.00)***	-0.03 (0.02)**	-0.03 (0.04)**	-0.02 (0.04)**
FD	-0.01 (0.82)	0.06 (0.12)	0.11 (0.07)*	0.11 (0.01)**	0.13 (0.01)***	0.09 (0.00)***
$EX * FD$	0.01 (0.84)	-0.12 (0.01)***	-0.13 (0.04)**	-0.14 (0.01)***	-0.15 (0.00)***	-0.09 (0.01)***
Panel H						
DPR	0.14 (0.00)***	0.10 (0.00)***	0.04 (0.01)***	0.03 (0.01)***	0.02 (0.08)*	0.01 (0.03)**
$EX * DPR$	-0.15 (0.00)***	-0.13 (0.00)***	-0.05 (0.00)***	-0.03 (0.02)**	-0.03 (0.04)**	-0.02 (0.03)**

FPS	-0.31 (0.09)*	0.16 (0.24)	0.40 (0.02)**	0.23 (0.06)*	0.18 (0.18)	0.13 (0.04)**
$EX * FPS$	0.34 (0.16)	-0.09 (0.60)	-0.28 (0.19)	0.00 (1.00)	0.03 (0.87)	0.11 (0.20)
Panel I						
DPR	0.14 (0.00)***	0.10 (0.00)***	0.04 (0.00)***	0.03 (0.00)***	0.02 (0.05)**	0.02 (0.01)**
$EX * DPR$	-0.15 (0.00)***	-0.13 (0.00)***	-0.06 (0.00)***	-0.03 (0.02)**	-0.03 (0.03)**	-0.02 (0.03)**
FDR	0.09 (0.48)	0.19 (0.02)**	0.29 (0.06)*	0.20 (0.08)*	0.27 (0.02)**	0.20 (0.00)***
$EX * FDR$	-0.16 (0.33)	-0.37 (0.00)***	-0.38 (0.02)**	-0.28 (0.02)**	-0.34 (0.01)***	-0.19 (0.01)***
Panel J						
DPR	0.13 (0.00)***	0.10 (0.00)***	0.04 (0.01)***	0.03 (0.01)***	0.02 (0.10)*	0.01 (0.04)**
$EX * DPR$	-0.14 (0.00)***	-0.12 (0.00)***	-0.05 (0.00)***	-0.03 (0.04)**	-0.03 (0.07)*	-0.02 (0.07)*
FCY	0.77 (0.89)	1.68 (0.75)	1.03 (0.74)	0.77 (0.73)	0.68 (0.69)	0.59 (0.51)
$EX * FCY$	-3.55 (0.53)	-3.39 (0.56)	-2.19 (0.50)	-1.34 (0.55)	-0.74 (0.73)	-0.71 (0.57)

Table E.2: Robustness tests of Table 4.3

This table replicates Table 4.3 (OLS regressions for effects of ownership holdings on the ex-dividend period irrational exuberance) replacing the percentage of individual ownership $INDO$ and the percentage of international ownership $INTO$ with the ownership dummy variables D_{INDO}/D_{INTO}. D_{INDO} takes the value of one when $INDO_{j,t}$ is above the higher quartile of $INDO_t$ across all companies in year t and zero when $INDO_{j,t}$ is below the lower quartile. D_{INTO} takes the value of one when $INTO_{j,t}$ is above the higher quartile of $INTO_t$ across all companies in year t and zero when $INTO_{j,t}$ is below the lower quartile. LMC is the log of market capitalization. BM is the ratio of the book value of equity to the market value of a firm's equity. QSP is the time-weighted average of limit order bid-ask spread. $IVOL$ is the standard deviation of the return based on the mid-point price for each quote update. The regression uses heteroskedasticity-consistent standard error estimator (Davidson and MacKinnon, 1993) and significance at the 10%, 5% and 1% levels is indicated by *, ** and ***, respectively. T-statistics are reported in parentheses.

$\overline{AAR}$	5-day	10-day	20-day	30-day	40-day	50-day
$CONST$	0.44(0.55)	0.56(0.12)	0.46(0.09)*	0.37(0.09)*	0.41(0.02)**	0.42(0.00)***
EX	-0.16(0.15)	-0.10(0.11)	-0.06(0.20)	-0.05(0.18)	-0.07(0.03)**	-0.08(0.00)***
D_{INDO}	0.20(0.10)*	0.13(0.06)*	0.15(0.00)***	0.13(0.00)***	0.10(0.00)***	0.07(0.00)***
$Ex*D_{INDO}$	-0.41(0.01)***	-0.23(0.01)**	-0.24(0.00)***	-0.22(0.00)***	-0.15(0.00)***	-0.08(0.01)**
D_{INTO}	0.05(0.64)	0.04(0.59)	0.05(0.29)	0.03(0.46)	0.03(0.34)	0.04(0.11)
$Ex*D_{INTO}$	-0.14(0.33)	-0.17(0.06)*	-0.10(0.12)	-0.05(0.34)	-0.03(0.42)	-0.05(0.14)
DY	6.43(0.19)	2.88(0.19)	0.33(0.82)	0.69(0.52)	0.26(0.77)	-0.47(0.46)
LMC	-0.03(0.36)	-0.02(0.13)	-0.02(0.07)*	-0.02(0.07)*	-0.02(0.01)**	-0.02(0.00)***
BM	-0.02 (0.27)	-0.01 (0.76)	0.00 (0.93)	0.01 (0.44)	0.01 (0.18)	0.01 (0.19)
QSP	-0.01 (0.45)	-0.01 (0.34)	0.01 (0.46)	0.00 (0.62)	0.01 (0.27)	0.00 (0.51)
$IVOL$	38.29 (0.36)	-5.63 (0.52)	-5.52 (0.60)	-7.93 (0.40)	-10.13 (0.26)	-10.94 (0.14)

Table E.3: Robustness tests of Table 4.4

This table replicates Table 4.4 (OLS regressions for the behaviourval finance dividend clientele) using multiple dividend variables and franking credits variables. D_{INDO} takes the value of one when $INDO_{j,t}$ is above the higher quartile of $INDO_t$ across all companies in year t and zero when $INDO_{j,t}$ is below the lower quartile. DPR is the dollar amount of dividend per share divided by earnings per share during the previous year. DY is the dollar amount of dividend per share, divided by the cum-dividend day closing price. FDR is the dollar amount of franking credits per share divided by the dollar amount of dividend per share. FL is 0 if the dividend is unfranked while it is 100 if the dividend is with fully franked. It can range between 0 and 100 if the dividend is partly franked. FD is a dummy variable that takes the value of one if the dividend is fully franked credits and zero if it is unfranked or partly franked. FPS is the dollar amount of franking credit per share. FCY is the dollar amount of franking credit per share, divided by the cum-dividend closing price. $\overline{AAR}$ is the average daily abnormal adjusted return on the ex-dividend date, during the cum-dividend period and the ex-dividend period using 5-day, 10-day, 20-day, 30-day, 40-day and 50-day windows. The regression uses heteroskedasticity-consistent standard error estimator (Davidson and MacKinnon, 1993) and significance at the 10%, 5% and 1% levels is indicated by *, ** and ***, respectively. T-statistics are reported in parentheses.

$\overline{AAR}$	5-day	10-day	20-day	30-day	40-day	50-day
Panel A						
$D_{INDO} * DY$	23.31(0.06)*	9.02(0.11)	5.05(0.06)*	5.97(0.00)***	5.34(0.01)***	3.37(0.01)***
$Ex * D_{INDO} * DY$	-14.90(0.30)	-10.33(0.10)*	-8.79(0.02)**	-8.42(0.00)***	-6.94(0.00)***	-3.72(0.03)**
$D_{INDO} * FL$	0.01(0.01)**	0.00(0.03)**	0.00(0.17)	0.00(0.40)	0.00(0.45)	0.00(0.94)
$Ex * D_{INDO} * FL$	-0.01(0.01)***	-0.01(0.03)**	-0.00(0.09)*	-0.00(0.59)	-0.00(0.33)	-0.00(0.51)
Panel B						
$D_{INDO} * DY$	22.90(0.07)*	8.79(0.12)	4.94(0.06)*	5.93(0.00)***	5.32(0.01)***	3.38(0.01)***
$Ex * D_{INDO} * DY$	-14.55(0.31)	-10.15(0.10)	-8.70(0.02)**	-8.40(0.00)***	-6.94(0.00)***	-3.77(0.02)**
$D_{INDO} * FD$	0.48(0.08)*	0.19(0.28)	0.05(0.67)	0.01(0.93)	-0.00(0.99)	-0.01(0.83)
$Ex * D_{INDO} * FD$	-0.66(0.08)*	-0.34(0.13)	-0.17(0.25)	-0.03(0.84)	-0.07(0.53)	-0.07(0.38)
Panel C						
$D_{INDO} * DY$	22.20(0.08)*	8.68(0.13)	4.89(0.06)*	5.90(0.00)***	5.41(0.01)***	3.47(0.00)***
$Ex * D_{INDO} * DY$	-13.25(0.36)	-9.99(0.11)	-8.61(0.02)**	-8.49(0.00)***	-7.08(0.00)***	-3.81(0.02)**
$D_{INDO} * FPS$	1.03(0.56)	-0.88(0.42)	-0.66(0.32)	-0.63(0.24)	-0.71(0.11)	-0.65(0.04)**

$Ex * D_{INDO} * FPS$	-3.98(0.08)*	-0.95(0.48)	-0.34(0.70)	-0.03(0.97)	0.31(0.59)	0.56(0.20)	
Panel D							
$D_{INDO} * DY$	23.31(0.06)*	9.02(0.11)	5.05(0.06)*	5.97(0.00)***	5.34(0.01)***	3.37(0.01)***	
$Ex * D_{INDO} * DY$	-14.90(0.30)	-10.33(0.10)*	-8.79(0.02)**	-8.42(0.00)***	-6.94(0.00)***	-3.72(0.03)**	
$D_{INDO} * FDR$	1.88(0.01)**	0.94(0.03)**	0.38(0.17)	0.19(0.40)	0.14(0.45)	0.01(0.94)	
$Ex * D_{INDO} * FDR$	-2.35(0.01)***	-1.18(0.03)**	-0.61(0.09)*	-0.16(0.59)	-0.24(0.33)	-0.12(0.51)	
Panel E							
$D_{INDO} * DY$	0.73(0.95)	-3.17(0.62)	2.03(0.59)	4.22(0.19)	4.56(0.15)	3.56(0.06)*	
$Ex * D_{INDO} * DY$	10.67(0.49)	3.92(0.61)	-4.78(0.30)	-6.57(0.09)*	-4.68(0.19)	-2.21(0.33)	
$D_{INDO} * FCY$	70.09(0.01)***	34.77(0.01)**	7.60(0.39)	3.68(0.59)	0.20(0.98)	-2.12(0.60)	
$Ex * D_{INDO} * FCY$	-84.81(0.01)***	-36.74(0.03)**	-6.03(0.58)	1.48(0.86)	-1.00(0.89)	-1.11(0.83)	
Panel F							
$D_{INDO} * DPR$		0.39(0.12)	0.31(0.04)**	0.10(0.07)*	0.09(0.12)	0.08(0.09)*	0.05(0.11)
$Ex * D_{INDO} * DPR$	-0.25(0.37)	-0.27(0.14)	-0.12(0.20)	-0.09(0.17)	-0.12(0.05)**	-0.09(0.03)**	
$D_{INDO} * FL$	0.01(0.02)**	0.00(0.04)**	0.00(0.15)	0.00(0.50)	0.00(0.62)	-0.00(0.94)	
$Ex * D_{INDO} * FL$	-0.01(0.01)**	-0.00(0.05)**	-0.00(0.08)*	-0.00(0.69)	-0.00(0.72)	-0.00(0.83)	
Panel G							
$D_{INDO} * DPR$	0.39(0.12)	0.31(0.04)**	0.10(0.08)*	0.09(0.12)	0.08(0.10)*	0.05(0.11)	
$Ex * D_{INDO} * DPR$	-0.25(0.36)	-0.27(0.14)	-0.12(0.20)	-0.09(0.18)	-0.12(0.05)*	-0.09(0.03)**	
$D_{INDO} * FD$	0.48(0.10)*	0.22(0.26)	0.07(0.55)	0.01(0.96)	-0.01(0.89)	-0.01(0.85)	
$Ex * D_{INDO} * FD$	-0.66(0.09)*	-0.34(0.16)	-0.20(0.21)	-0.02(0.88)	-0.01(0.90)	-0.04(0.58)	
Panel H							
$D_{INDO} * DPR$	0.40 (0.13)	0.32 (0.04)**	0.10 (0.08)*	0.09 (0.12)	0.08 (0.10)*	-0.05 (0.10)	

$Ex * D_{INDO} * DPR$	-0.24 (0.40)	-0.27 (0.15)	-0.12 (0.22)	-0.09 (0.19)	-0.13 (0.05)*	-0.09 (0.03)**
$D_{INDO} * FPS$	-0.35 (0.86)	-1.84 (0.17)	-0.99 (0.16)	-1.00 (0.09)*	-1.05 (0.03)**	-0.86 (0.02)**
$Ex * D_{INDO} * FPS$	-2.64 (0.27)	0.11 (0.94)	-0.02 (0.99)	0.24 (0.74)	0.78 (0.22)	0.81 (0.08)*
Panel I						
$D_{INDO} * DPR$	0.39 (0.12)	0.31 (0.04)**	0.10 (0.07)*	0.09 (0.12)	0.08 (0.09)*	0.05 (0.11)
$Ex * D_{INDO} * DPR$	-0.25 (0.37)	-0.27 (0.14)	-0.12 (0.20)	-0.09 (0.17)	-0.12 (0.05)**	-0.09 (0.03)**
$D_{INDO} * FDR$	1.82 (0.02)**	0.96 (0.04)**	0.42 (0.15)	0.16 (0.50)	0.10 (0.62)	-0.01 (0.94)
$Ex * D_{INDO} * FDR$	-2.35 (0.01)**	-1.14 (0.05)**	-0.64 (0.08)*	-0.12 (0.69)	-0.10 (0.72)	-0.04 (0.83)
Panel J						
$D_{INDO} * DPR$	-0.02 (0.94)	0.14 (0.26)	0.01 (0.84)	0.01 (0.81)	0.02 (0.70)	0.02 (0.49)
$Ex * D_{INDO} * DPR$	0.11 (0.68)	-0.05 (0.75)	0.06 (0.52)	0.03 (0.58)	-0.01 (0.80)	-0.02 (0.65)
$D_{INDO} * FCY$	73.19 (0.01)**	25.27 (0.04)**	10.97 (0.11)	9.88 (0.02)**	6.31 (0.14)	1.76 (0.52)
$Ex * D_{INDO} * FCY$	-73.81 (0.02)**	-25.30 (0.06)*	-15.00 (0.12)	-8.56 (0.13)	-5.91 (0.25)	-3.11 (0.44)

Appendix F

Variable specification

Table reports the variable specification in the thesis.

Table F.1: Variable specification

This table specifies the definition, formula, measure and literature of the variables used in the thesis. The dependent variable is the daily relative price premium. Independent variables are effective tax rate premium dummy and estimated price premium. Control variables include lagged log return premium, log returns of index and exchange rate, bid-ask spread, lagged turnover ratio and log returns of GDP, CPI, imports, exports, current account and unemployment rate. This table is developed for this research.

Variable	Definition	Formula	Measure
Panel A: Dependent Variables			
Price Premium (PR_t)	Relative price premium between BHP ADR and Billiton ADR	$PR_t = \frac{BHPADR_t - BillitonADR_t}{(BHPADR_t + BillitonADR_t)/2}$	Mispricing between the BHP twins (Grossmann et al., 2007)
Panel B: Independent Variables			
Effective tax rate difference dummy (D_i)	Dummy equal to one affter the effective tax rate difference dummy change date	$D_i = \begin{cases} 1 \text{ after the effective tax rate difference dummy change date} \\ 0 \text{ before the effective tax rate difference dummy change date} \end{cases}$ where i is from 1 to 5 stands for five tax rate changes	Tax factors difference between Australia and the UK
Estimated price premium ($E(PR_t)$)	Relative estimated price difference between BHP and Billiton using GGM and RIM	$E(PR_t) = \frac{E(BHPADR_t) - E(BillitonADR_t)}{(E(BHPADR_t) + E(BillitonADR_t))/2}$	Estimated mispricing incorporating tax factors between the BHP twins using GGM (Gordon and Shapiro, 1956) and RIM (Ohlson, 2001)

Panel C: Control Variables			
Lagged log return premium ($LLRPR_t$)	Premium of lagged log return of BHP ADR over Billiton ADR	$LLRPR_t = log(P_{BHP,t-1}/P_{BHP,t-2}) - log(P_{Billiton,t-1}/P_{Billiton,t-2})$.	Autocorrelation (Keele and Kelly, 2006)
Index log return (r_{index_t})	Natural log value of index return for ASX 200, FTSE 100, and S&P 500	$r_{index_t} = log(P_{index_t}/P_{index_{t-1}})$, where P_{index_t} is the price of index on date t, *index* are ASX 200, FTSE 100 and S&P 500.	Market return (Froot and Dabora, 1999)
Exchange rate log return (r_{AUD_t}/r_{GBX_t})	Natural log of exchange rate of AUD and GBX	$r_{AUD_t} = log(P_{AUD_t}/P_{AUD_{t-1}})$, $r_{GBX_t} = log(P_{GBX_t}/P_{GBX_{t-1}})$, where P_{AUD_t} is the price of AUD on date t, P_{GBX_t} is the price of GBX on date t.	Market return (Copeland and Copeland, 1998)

Weighted bid-ask quoted spread (WSP_t)	Eigen weighted sum of the time-weighted quoted bid-ask spread	WSP_t $= \Sigma_{x=1}^{s} w_s \times QSP_{s,t}$, where $QSP_{s,t} = \frac{\Sigma_{t=1}^{N}(QSP_{s,t,n} * Du_{s,t,n})}{\Sigma_{t=1}^{N} Du_{s,t,n}}$, $QSP_{s,t,n} = \frac{AskPr_{s,t,n} - BidPr_{s,t,n}}{(AskPr_{s,t,n} + BidPr_{s,t,n})/2}$, w_s is the weight of security s determined by the eigenvector, $AskPr_{s,t,n}$ is the ask price for security s on date t for quote n, $BidPr_{s,t,n}$ is the bid price for security s on date t for quote n, $Du_{s,t}$ is the duration for security s on date t for quote n, n stands for quote number, s are BHP ADR, Billiton ADR, BHP ASX, and Billiton LSE.	Transaction cost (McInish and Wood, 1992; Pontiff, 1996)

Lagged turnover ratio ($LTR_{s,t}$)	The lagged turnover ratio of BHP ASX, Billiton LSE, BHP ADR, and Billiton ADR	$LTR_{s,t} = \frac{Trade\ Volume_{s,t-1}}{Share\ Outstanding_{s,t-1}}$, where $Trade\ Volume_{s,t-1}$ is the trading volume for security s on date $t-1$, $Shares\ Outstanding_{s,t-1}$ is the number of shares outstanding for security s on date $t-1$, s are BHP ADR, Billiton ADR, BHP ASX, and Billiton LSE.	Liquidity (Hu, 1997)
GDP log return ($r_{GDP,AU_t}/r_{GDP,UK_t}$)	Natural log return of GDP for Australia and the UK	$r_{GDP,AU_t} = log(GDP_{AU_t}/GDP_{AU_{t-1}})$, $r_{GDP,UK_t} = log(GDP_{UK_t}/GDP_{UK_{t-1}})$, where GDP_{AU_t} is the gross domestic product of Australia on date t, GDP_{UK_t} is the gross domestic product of the UK on date t.	Economic indicator (Su et al., 2013)
CPI log return ($r_{CPI,AU_t}/r_{CPI,UK_t}$)	Natural log return of CPI for Australia and the UK	$r_{CPI,AU_t} = log(CPI_{AU_t}/CPI_{AU_{t-1}})$, $r_{CPI,UK_t} = log(CPI_{UK_t}/CPI_{UK_{t-1}})$, where CPI_{AU_t} is the consumer price index of Australia on date t, CPI_{UK_t} is the consumer price index of the UK on date t.	Economic indicator (Su et al., 2013)

Imports log return ($r_{Imports,AU_t}/r_{Imports,UK_t}$)	Natural log return of imports for Australia and the UK	$r_{Imports,AU_t} = log(Imports_{AU_t}/Imports_{AU_{t-1}})$, $r_{Imports,UK_t} = log(Imports_{UK_t}/Imports_{UK_{t-1}})$, where $Imports_{AU_t}$ is the imports of Australia on date t, $Imports_{UK_t}$ is the imports of the UK on date t.	Economic indicator (Su et al., 2013)
Exports log return ($r_{Exports,AU_t}/r_{Exports,UK_t}$)	Natural log return of exports for Australia and the UK	$r_{Exports,AU_t} = log(Exports_{AU_t}/Exports_{AU_{t-1}})$, $r_{Exports,UK_t} = log(Exports_{UK_t}/Exports_{UK_{t-1}})$, where $Exports_{AU_t}$ is the exports of Australia on date t, $Exports_{UK_t}$ is the exports of the UK on date t.	Economic indicator (Su et al., 2013)
Current account log return ($r_{CA,AU_t}/r_{CA,UK_t}$)	Natural log return of current account for Australia and the UK	$r_{CA,AU_t} = log(CA_{AU_t}/CA_{AU_{t-1}})$, $r_{CA,UK_t} = log(CA_{UK_t}/CA_{UK_{t-1}})$, where CA_{AU_t} is the CA of Australia on date t, CA_{UK_t} is the CA of the UK on date t.	Economic indicator (Su et al., 2013)
Unemployment rate log return ($r_{UR,AU_t}/r_{UR,UK_t}$)	Natural log return of unemployment rate for Australia and the UK	$r_{UR,AU_t} = log(UR_{AU_t}/UR_{AU_{t-1}})$, $r_{UR,UK_t} = log(UR_{UK_t}/UR_{UK_{t-1}})$, where UR_{AU_t} is the UR of Australia on date t, UR_{UK_t} is the UR of the UK on date t.	Economic Indicator (Su et al., 2013)